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ABSTRACT

Data from administration of the Bruininks-Oseretsky Test of Motor Proficiency and the Cornish Test of Motor Planning were taken on 120 children (5-13 years old), 60 of whom had been classified learning disabled (LD). Thirty of the LD Ss had been assigned to adapted physical education. The study sought to do two things: (1) determine whether the commonly used Bruininks-Oseretsky Test is valid in determining whether a child is in need of adapted physical education; and (2) determine whether the new, simpler Cornish Test might be useful for the same purpose, either solely or in conjunction with the Bruininks Test. The Bruininks-Oseretsky Test was found to accurately identify about 90% of the children needing adapted physical education. Long-term reliability was very satisfactory. The Cornish Test equaled predictive ability of the other test, although certain problems in test administration were noted, including unclear directions. The study focuses on the decision successfulness of the tests examined, the most appropriate framework in which to judge the validity of tests used for assignment and placement purposes. Joint use of the two tests did not improve decision accuracy. (CL)

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A Decision-Theoretic Examination of the Usefulness of Two Motor Performance Tests in Identifying Children for Assignment to Adapted Physical Education

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FOREWORD

The authors would like to thank Ms. Jan Patterson, Adapted Physical Education Specialist, Encinitas Union School District, for her excellent and knowledgeable contributions to this study in both its practical and conceptual aspects. We would also like to thank Don Lindstrom, Superintendent, Encinitas Union School District, and the Board of Education for the Encinitas Union School District for their kind help and cooperation in our conducting this study.

This study was supported by a Special Study grant (37-03651-X842-00-83) from the Special Needs Division, California State Department of Education. Findings, conclusions, and other opinions expressed in this report are those of the authors and they do not reflect the official position of the California State Department of Education nor of the sponsoring agency, and no endorsement is implied.

EXECUTIVE SUMMARY

In recent years, there have been a number of strong criticisms made about the practices that are being employed to decide whether children should be assigned to special and remedial education services. These criticisms have encompassed concerns about the quality of assessment instruments being used, the manner in which decisions are being made from the test scores yielded by these instruments, and about the excessive cost and time of the decision procedures relative to their demonstrated usage in the decision process. These concerns caused one prominent group of researchers to conclude that "time and resources would be spent more appropriately in teaching and instructing rather than in testing and labeling".

These kinds of matter have not been examined within the framework of decision making for Adapted Physical Education, and this study attempted to make a start in this direction. We essentially sought to do two things: first, to determine whether the test commonly being used for determining whether a child is in need of Adapted Physical Education, the Bruininks-Oseretsky Test of Motor Proficiency - Short Form, is indeed valid for this "purpose for which it is being used" (as required by Federal mandate); second, to determine whether a newly-proposed and rather simple test, the Cornish Test of Motor Planning, might be useful for the same purpose, either solely or in conjunction with the Bruininks Test.

Throughout this study, our focus was on the decision successfulness of the tests examined. This, we have held, is the only proper framework in which to judge the validity of tests used for assignment and placement purposes. Too few of the many tests being used for criterion-referenced purposes in education have not, and are not, being examined in this light. Our study is an attempt to rectify that fact in relation to the physical performance tests being used in special education settings.

Data from one administration of the Bruininks-Oseretsky Short Form Test and from two administrations of the Cornish Test were taken on 120 children in a California school district. Ages of the children ranged between 5 yrs 2 mos and 13 yrs 1 month. Sixty of these children had been classified as learning disabled by decision teams of the school district: 30 of these learning disabled children had been assigned to Adapted Physical Education, (similarly by decision teams of the school district), and 30 had not. The remaining 60 children had been considered non-disabled, and therefore not been assigned to APE.

For each of the learning disabled children, we examined the IEP folders maintained by the school district, hoping to find in them some other standardized test scores that could be investigated as possible predictors of APE assignment. The tests found included PIAT, WRAT, Beery Visual Motor, DIS Speech Placement, and BMAT. However, as found by Ysseldyke and his colleagues, the pattern of collection of these were very inconsistent, and we had insufficient data to make any sense from them.

Additional to this data, we had available Bruininks-Oseretsky test data (Long and Short Forms) collected 17 months previous on 21 of the learning disabled children. Access to this data enabled us to additionally examine the long-term reliability of the Bruininks-Oseretsky Short Form test.

Findings concerning the Bruininks-Oseretsky Test were positive. For both a mixed sample of learning disabled and non-disabled students, and for a sample of learning disabled students alone, the Test could, with a suitable cutting score, accurately identify about 90% of the children needing APE. This cutting score was in the range of about 35 to 40, the possibility of sampling error guarding us against a more definitive prescription. The long-term reliability of the Test was also demonstrated to very satisfactory.

The Cornish Test, too, demonstrated a good level of success in predicting assignment to APE. For learning disabled students alone, its accuracy was equal to that of the Bruininks Test. A number of problems with the Test were found, however, that interfered with our positive acceptance of it: test directions were unclearly specified, and this would undoubtedly lead to somewhat poorer validation accuracy among inexperienced testers. This problem could probably be rectified fairly easily, however, and the possible low cost advantages of this Test might make it a possible alternative to the Bruininks Test.

Our last topic of investigation concerned determining whether the joint use of the Bruininks and Cornish tests could improve decision accuracy. This was not found to be the case, even though the tests had a rather low mutual correlation. Decision accuracy remained just about the same as it was for the Bruininks Test alone, even when results from the two tests were combined optimally. This result underscored, in small part, some of the criticisms noted above, especially in that it apprises us to the simple fact that "more" is very often not "better". Indiscriminate collection of assessment data costs a good deal of money, and diminishes the time and resources that can be allotted to actual instruction. Unless it can be rather certainly shown to significantly improve decision practice, it cannot be defended or condoned.

How can these findings be summarized in a simple, summary prescription? (1) We would have to say that one of the instruments commonly being used at present appears to be able to mimic well the kinds of assignment decisions being made. This is not to say, of course, that the decisions are correct, for this kind of inference would require a study of greatly increased scope from the present one. Nevertheless, the result is a little reassuring. (2) It seems to be a sound inference that less costly and simpler tests could probably be used to make assignment decisions with about the same accuracy as is being achieved at present. The particular "new" test we studied could not be considered to be optimal in this regard. (3) We see no evidence in the literature we have read, nor in our results, to suggest that the collection of test data beyond a rather bare minimum is likely or capable of much improving decision practices. We found that anecdotal data about a student (e.g."he/she is a behavior problem": "he/she is not doing well in regular p.e."), and not extra test data, was most explicatory of APE/Non APE assignments that had not followed what a single test would have prescribed.

TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY	i
TABLE OF CONTENTS	iv
LIST OF TABLES	vi
LIST OF FIGURES	ix
INTRODUCTION	1
Statement of Purpose	
Perceived Problems with Present Practices in APE	
Specific Questions Investigated in This Study	
Study Approach	
Data Collection Procedures	
Methods of Analysis	
FINDINGS	12
General Analyses	
Specific Analyses	
CONCLUSIONS AND RECOMMENDATIONS	43
BIBLIOGRAPHY	45
APPENDICES	
A. Letter of Approval for Human Subjects Use, San Diego State University	48
B. Letter of Approval for Human Subjects Use, Encinitas Union School District	49
C. Parent Permission Form for Use of IEP Folders	50
D. Items and Instructions for the Cornish Test of Motor Planning	51
E. Outline of Statistical Methods for Decision Validation	57
F. Raw Data on Motor Performance Collected in October/November 1983	64
G. A Key to Acronyms Used for Variables in the Data Set of Appendix F	69
H. Raw Data for 21 "Repeat" Subjects (collected May, 1982 and October/November, 1983)	70

I. A Key to Acronyms Used for Variables in the "Repeat" Data Set of Appendix H 71

J. Tables of Descriptive Statistics for October/ November, 1983 Data 72

LIST OF TABLES

1. Items on the Bruininks-Oseretsky Short Form Test . . . 7

2. Items on the Cornish Test of Motor Planning 8

3. Analysis of Variance Comparing Means of Three Groups on Age 13

4. Analysis of Variance Comparing Means of Three Groups on Bruininks Raw Score 15

5. Analysis of Variance Comparing Means of Three Groups on Bruininks Standard Score 16

6. Analysis of Variance Comparing Means of Three Groups on Cornish % of Developmental Age Score (Administration 1) 17

7. Analysis of Variance Comparing Means of Three Groups on Cornish % of Developmental Age Score (Administration 2) 18

8. Decision Validity Coefficients for Different Cutting Scores on the Bruininks-Oseretsky Short Form Test (Standard Score) for All Students 21

9. Decision Validity Coefficients for Different Cutting Scores on the Bruininks-Oseretsky Short Form Test (Standard Score) for Learning Disabled Students 22

10. Correlations Between Bruininks-Oseretsky Test Scores Taken in May 1982, and Cornish Test and Bruininks-Oseretsky Test Scores Taken in October/November 1983 for 21 Learning Disabled Children 24

11. Comparison of Group Mean Scores on Bruininks-Oseretsky Short Form Test Taken at Three Different Times for 21 Learning Disabled Children . 25

12. Comparison of Means of First and Second Cornish Test Scores for Each of Three Groups and the Total Group 27

13. Decision Validity Coefficients for Different Cutting Scores on the Cornish % Developmental Age Score (Admin. 1), All Students 28

14. Decision Validity Coefficients for Different Cutting Scores on the Cornish % Developmental Age Score (Admin. 2), All Students 29

15. Decision Validity Coefficients for Different Cutting Scores on the Cornish % Developmental Age Score (Admin. 1), Learning Disabled Students . 30

16. Decision Validity Coefficients for Different Cutting Scores on the Cornish % Developmental Age Score (Admin. 2), Learning Disabled Students . 31

17. A Decision Reliability Analysis of the Cornish Test for the Total Group 33

18. Correlations Between Test Scores for Total Group (N=120) 35

19. Correlations Between Test Scores, Learning Disabled - APE Students (N=30) 36

20. Correlations Between Test Scores, Learning Disabled - No APE Students (N=30) 37

21. Correlations Between Test Scores, Non-Disabled Students (N=60) 38

22. Discriminant Analysis to Predict APE Assignment Status from Bruininks-Oseretsky and Cornish Test Scores 40

23. Decision Validity Coefficients Using Both Bruininks and Cornish Test (Administration 1) Scores To Predict APE Assignment 41

24. Decision Validity Coefficients Using Both Bruininks and Cornish Test (Administration 2) Scores To Predict APE Assignment 42

25. The Classification Table as Used in This Study . . 60

26. Strong and Weak Inference Strategies in Decision Classification Using Two Decision Tests 63

27. A Key to Acronyms Used for Variables in the Data Set of Appendix F 69

28. A Key to Acronyms Used for Variables in the "Repeat" Data Set of Appendix H 71

29. Descriptive Statistics, All Variables, All Groups, October/November 1983 Data (N=120) 72

30. Descriptive Statistics, All Variables, Learning Disabled - APE Students (N=30) 73

31. Descriptive Statistics, All Variables, Learning Disabled - No APE Students (N=30) 74

32. Descriptive Statistics, All Variables, Non-Disabled Students (N=60) 75

LIST OF FIGURES

1. Conceptual Structure of Motor Performance Data Used in This Study 9

INTRODUCTION

Statement of Purpose

This study examined the usefulness of two tests of motor performance -- the Bruininks-Oseretsky Test of Motor Proficiency - Short Form ("Bruininks Test"), and the Cornish Test of Motor Planning ("Cornish Test") -- in helping make decisions about the assignment of Learning Disabled Children to special education services, specifically to Adapted Physical Education (APE).

Perceived Problems with Present Testing Practices in APE

Under Public Law 94-142 and the California Master Plan (as expressed in the Title 5 regulations), it is mandated that an Individualized Educational Program (IEP) be developed for each student determined to be handicapped and in need of special education services (Hinkle, 1981). The IEP is based to a great degree on test data, and is developed by a team of at least three specified individuals within 50 days after the parents sign the consent for assessment. This process must take place for each individual with special needs (approximately 357,000 students in California in 1981-1982).

Decisions about a child's educational placement and care (including the IEP) are made to a large extent on the basis of test data (or "assessment data") collected on the child. A large number of disturbing questions have been raised about assessment, and decision-making practices which result from such testing, by researchers at the Minnesota Institute for Research on Learning Disabilities (Ysseldyke, Thurlow, Graden, Wesson, Algozzine, & Deno, 1983). These researchers, working under a 5-year Federal grant, have conducted investigations leading to the publication of over 100 research reports and monographs. Among their many generalized findings were:

- "The special education team decision-making process, as currently employed in public school settings, is at best inconsistent"
- "Placement decisions made by teams of individuals have very little to do with the data collected on students"
- "Most tests currently used in the psychoeducational decision-making process are technically inadequate"

To the present authors, there are equally disturbing questions about the procedures that appear to be being used in assessing motor performance abilities of children for the purpose of deciding whether they should be assigned to APE. Some of these questions relate to doubt about whether the test most commonly used for this purpose, the Bruininks-Oseretsky Short Form test, is truly valid, specifically in terms of the purposes for which it is being used, namely assignment to APE.

These are questions concerning the technical adequacy of the test (Problem 1, below). A second set of questions relates to how the assessment procedures (and their later analysis in the IEP meeting) might be carried out more economically. These are questions concerning the cumbersomeness and costliness of present procedures (Problem 2, below). Each of these two issues will be considered separately below to set a framework which will clarify our study purpose.

Problem 1: Technical Characteristics are Unknown

A great many tests are currently being used across the nation to provide information for the IEP process (Poland, Ysseldyde, Thurlow & Mirkin, 1979). The most widely used test for determining placement in physical education of non-physically handicapped children has been the Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978; Lewko, 1976). This test exists in two forms -- the Long Form and the Short Form -- and is widely used in California. Because of its shorter administration time, the Short Form (14 items) is more commonly used than the Long Form (46 items).

The Protection in Evaluation Procedures (PEP) provisions of Public Law 94-142 led to specific rules and regulations concerning assessment procedures used in making IEP decisions (Federal Register, August 23, 1977, pp. 42474-42518). These regulations included that: "Tests that are used must have been been validated for the specific purpose for which they are used." This suggests the crucial importance of thorough study of the characteristics of the tests that are being used for placement purposes, particularly those characteristics that are directly related to their successfulness in aiding correct decisions about a child's placement.

Researchers have questioned whether the tests generally being used in special/remedial education satisfy the vaidity demand of the Federal mandate. After surveying present practices, Ysseldyke and Algozzine (1982, p. 138) stated unequivocally that:

> Professionals who assess students to make decisions about them use technically inadequate data-collection procedures.

Thurlow and Ysseldyke found that many of the tests presently being used are technically inadequate in terms of their use of appropriate norms, their validity, and their reliability (Thurlow & Ysseldyke, 1979). Whether the widely-used Bruininks-Oseretsky Short Form test is indeed valid and reliable for the purposes for which it is being used -- to assist in deciding whether children should be assigned to Adapted Physical Education -- is not known, nor has it been adequately studied.

The major problem with studies that have been made of the validity of the Bruininks-Oseretsky tests (Long and Short forms)

has been that they have been studied outside the framework of the "specific purpose for which they are used" [i.e. the assignment decision] as required by Federal regulation. Validity of the Long Form test seems to have been presumed from the consistent finding that non-handicapped students perform better on the test than handicapped students (Bruininks, 1978; Bruininks, Sullivan, & Short, 1974; Staples & Bruininks, 1977; Bruininks & Bruininks, 1977). This kind of validation evidence is, however, inadequate to show that a test leads to better decision practices.

A good part of the problem in establishing whether motor performance tests being used for Adapted Physical Education placement (and particularly the Bruininks-Oseretsky Short Form test) are valid and reliable stems from inappropriate views that have been taken about what is meant by validity and reliability. In recent years, along with the development of concepts related to competency-based standards and criterion-referenced testing (Hambleton, Swaminathan, Algina, & Coulson, 1978), new perspectives on validity and reliability have emerged -- the concepts of decision validity (Hambleton, 1980; Washburn & Safrit, 1982) and decision reliability (Subkoviak, 1980; Swaminathan, Hambleton, & Algina, 1974).

Decision validity regards a test or assessment instrument as valid only insofar as it correctly predicts the kinds of decision that the test claims to assess. This contrasts with the traditional view which is satisfied with a single correlation coefficient (the validity coefficient) that expresses the extent to which the linear orderings of scores on two different tests are in agreement. The traditional view of validity is inappropriate in a decision framework, for it concerns itself with the consistency between measures rather than decision successfulness. Linn (1979) stresses the point: "Questions of validity are questions for the soundness of the interpretations of a measure .... . Thus it is the interpretation rather than the measure that is [to be] validated."

The decision validity framework should clearly be recognized as the one that is most meaningful for the problem we are considering -- ascertainment of the correctness of the assignment of children to different kinds of educational service. Part of this study examined the validity of the Bruininks-Oseretsky test in terms of its ability to make proper decisions about the assignment of both non-disabled and learning disabled children in Adapted Physical Education. As part of this phase of the study, we were also able to examine the long term reliability of the Bruininks-Oseretsky test by utilizing data collected about 17 months previous for purposes of another study.

Problem 2: Present testing seems cumbersome and costly

Some of the most disturbing findings of the studies of

Ysseldyke and his colleagues (Ysseldyke et al., 1983) concern the inefficacy with which assessment data are used by decision teams (Ysseldyke & Algozzine, 1982, pp. 145-148; Ysseldyke, Algozzine, Richey, & Graden, 1982). This is particularly troubling in light of the fact that the costs of assessment and decision-making for a single student have been estimated to be as high as $1,800 (Mirkin, 1980). The cost of an IEP meeting alone in the State of California has recently been estimated to be in the range $35 to $750 (Enell & Barrick, 1983, pp. 8-13), and the costs of preparation and development of the IEP (before and after the meeting) are likely to bring the cost into the range of Mirkin's estimate. These considerations led Ysseldyke et al (1983) to reach the implication from their research that "time and resources would be spent more appropriately in teaching and instructing rather than in testing and labeling" (p. 88).

The cautions that have been raised concerning the use of testing in the broader remedial/special education setting should alert us to question the soundness of our assessment practices for Adapted Physical Education. Specifically, here we have wished to consider whether the assessment processes used in determining which children do or do not get assigned to APE might be greatly curtailed and simplified, and whether the use of simpler assessment instruments might be sufficient.

Concerning the first issue raised (i.e. the possible simplification of the assessment processes), it seems wise to consider how effective the use of a single test instrument would be for determining APE assignment, and further, to assess what the actual benefit seems to be of using multiple assessment scores. Concerning the second issue raised, (the possibility of simpler test instruments), we should investigate any newer and simpler tests that might prove to be useful. The high case loads and peripatetic nature of most adapted physical education teachers create a particular need for assessment instruments that are quickly and easily administered, that use minimal equipment, but that are sensitive indicators of what kinds of educational service might best benefit a child's development. The recently proposed Cornish Test of Motor Planning (Cornish, 1980) is one such test that might have potential to determine the placement of many non-physically handicapped children in physical education.

Specific Questions Investigated in This Study

The following specific questions were investigated:

Question 1: To what extent is the Bruininks-Oseretsky Short Form test valid in the specific terms of its successfulness in making correct decisions about the assignment of children to Adapted Physical Education? To what extent does this

successfulness differ for a heterogeneous ("mixed") population (containing both Non Disabled and Learning Disabled children) and a population containing only Learning Disabled children? How should test scores best be used to lead to correct assignment decisions?

Question 2: To what extent are Bruininks-Oseretsky test scores consistent (in the decision sense) over a period of 17 months? (Note that this can be answered only relative to Learning Disabled students.) Are the early scores good predictors of what time shows a child's motor outcomes to become?

Question 3: To what extent is the Cornish Test of Motor Planning successful in predicting correct decisions about the assignment of children to Adapted Physical Education? Is its successfulness and appropriateness dependent on whether it is assessing a mixed population of children, or Learning Disabled children only? How should test scores best be used to lead to correct assignment decisions?

Question 4 : Is the Cornish Test of Motor Planning sufficiently reliable (in the sense of consistent decision) for use with either a mixed population of children or with Learning Disabled students only? To what extent can alternative test interpretation procedures (i.e. different cutting scores) affect the reliability?

Question 5 : Do either the Bruininks-Oseretsky Short Form or the Cornish Test of Motor Planning seem superior for the purpose of identifying children in need of Adapted Physical Education? Does this superiority differ for mixed populations of children and Learning Disabled children? Can the tests be used conjointly to lead to more accurate decision making?

Study Approach

In order to address the five questions posed above, the following motor performance data were collected and analyzed.

(1) In October/November, 1983, data were collected on 60 Learning Disabled subjects. Twenty one of these students had been originally tested as part of a previous study (Patterson, 1983), and thus 39 new Learning Disabled students were added for the present study. Data on the same measures were also taken on 60 Non-Disabled students of the same approximate age and from the same school district. Thirty of the Learning Disabled children had been assigned (by a school district IEP team) to APE -- this group is hereinafter referred to as the "Learning

Disabled - APE" group. The other 30 Learning Disabled children had been judged by IEP teams as not warranting assignment to APE; this group is referred to as the "Learning Disabled - No APE" group. Of course, none of the 60 Non-Disabled children had been assigned to APE, and they are referred to as the "Non-Disabled" group.

For all students in each of these three groups, data on the following measures were taken:

(a) 3 Demographic variables -- Group Designation of the student (Learning Disabled students assigned to APE, Learning Disabled students not assigned to APE, and Non-Disabled students), Age, and Sex.

(b) 16 scores on a single administration of the Bruininks-Oseretsky Short Form Test; this included the 14 subtest scores, and the 2 composite scores (Raw score and Standard score). A listing of the subtest items and standard scores of the Bruininks-Oseretsky Short Form Test is given in Table 1.

(c) 20 scores from two administrations of the Cornish Test of Motor Planning. Each administration yielded 10 scores -- one from each of the 6 subtests, 3 error scores, and a composite "% of Developmental Age" score. A listing and brief description of the subtest items and composite "% of Developmental Age" score is given in Table 2. A full description of items on the Cornish test is given in Appendix D, and in Cornish (1980).

(2) One set of scores on the Bruininks-Oseretsky Long Form test, and two sets of scores on the Bruininks-Oseretsky Short Form test were taken from 60 Learning Disabled children (ages 6.0 - 13.5; 44 boys and 16 girls) in May, 1982. Thirty of these children had been assigned to Adapted Physical Education, thirty had not. (These data are fully reported in Patterson, 1983). Part of the intent of the present study had been to collect additional data on as many of these subjects as was possible. Data could be collected from 21 of the original subjects, and thus 39 new Learning Disabled children were added to the study as explained above.

The overall structure and relationship of these two data sets is shown in conceptual form in Figure 1.

In addition to the motor performance data collected (as described above), the IEP folders of each of the 60 Learning Disabled children in the study were examined to extract the educational planning decision made for each child, and the profile of test scores that were contained in the IEP folder.

Table 1

Items on the Bruininks-Oseretsky Short Form Test

Item	
1	Running Speed and Agility
2	Standing on preferred leg on balance beam
3	Walking forward heel-to-toe on balance beam
4	Tapping feet alternately while making circles with fingers
5	Jumping up and clapping hands
6	Standing Broad Jump
7	Catching a tossed ball with both hands
8	Throwing a ball at a target with preferred hand
9	Response speed
10	Drawing a line through a straight path with preferred hand
11	Copying a circle with preferred hand
12	Copying overlapping pencils with preferred hand
13	Sorting shape cards with preferred hand
14	Making dots in circle with preferred hand

Short Form Scoring

1. After test administration convert performance on each item (raw score) to a point scale using the scale provided in the manual. For items with more than one trial, choose the best performance.

2. Add point scores for all 14 short form items and record total in Test Score Summary Section.

3. Consult Examiners manual for norms table.

Table 2

Items on the Cornish Test of Motor Planning

1. Imitative Crawling : Examiner demonstrates four different movement sequences involving both arms and legs. Child imitates after each demonstration.

2. Rope Test A : Child walks along a 24' coiled rope by placing right foot on left side of the rope and left foot on right side of the rope without touching the rope.

3. Rope Test B : The child walks along the rope tandem style and jumps when he/she comes to an intersection on the rope.

4. Jumping Jacks : Child performs as many jumping jacks as he/she can in ten seconds.

5. Throw-Clap-Catch : The child throws the ball up, claps his/her hands, and then catches the ball. Performs as many times as possible in 30 seconds.

6. Grasp Strength : Child squeezes the dynamometer with his/her dominant hand.

Overall Composite Score is determined by the following steps:

1. S = Imitative Crawling + Jumping Jacks + (60-Rope A) + (60-Rope B) + (3x Throw-Clap-Catch) + (4x Dominant Strength)

2. Developmental Age (Estimated) in months = $\frac{S}{2} - 23$

3. % Developmental Age (Estimated) = $\frac{\text{Developmental Age (Estimated)}}{\text{Chronological Age}} \times 100\%$

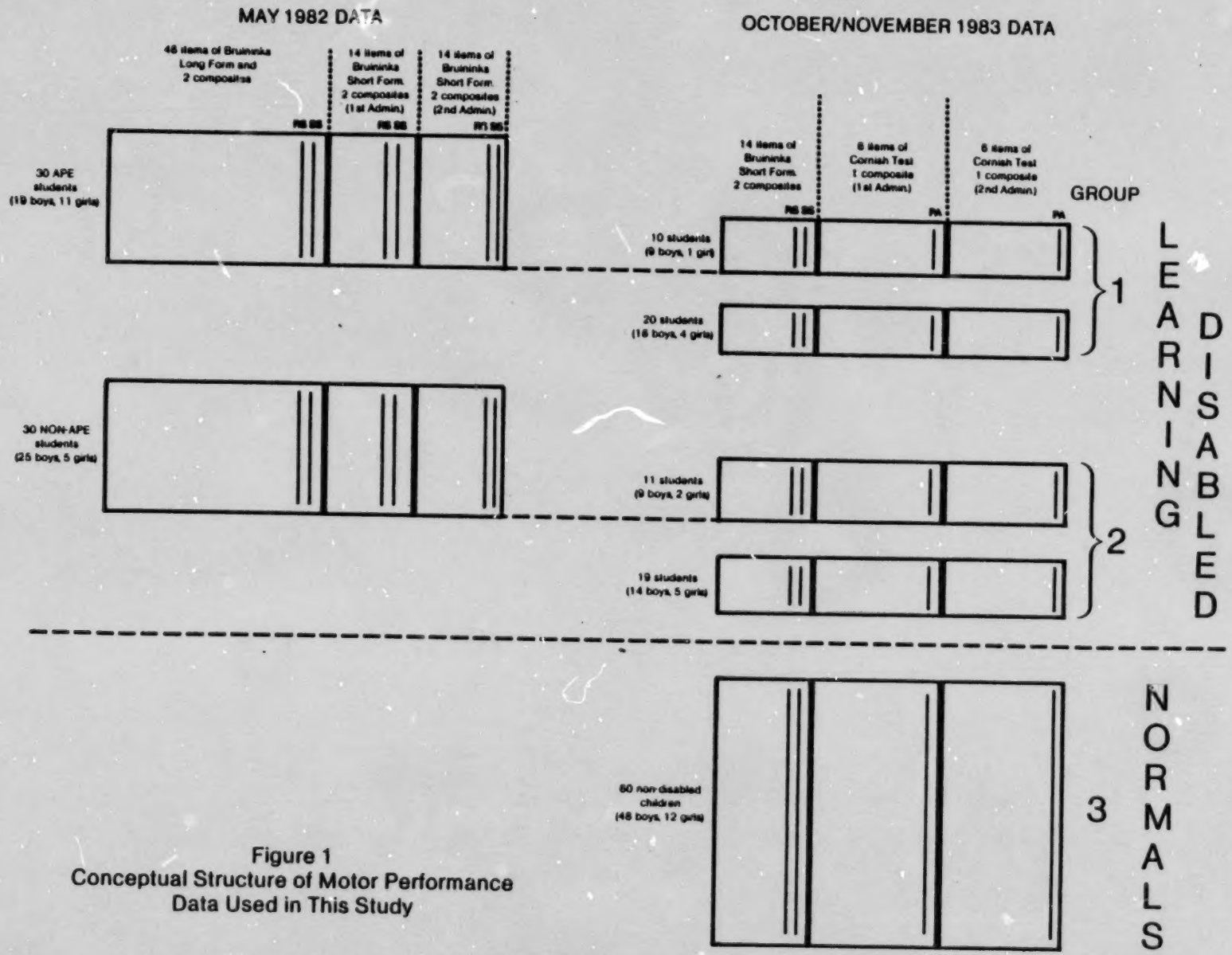
MAY 1982 DATA
OCTOBER/NOVEMBER 1983 DATA
46 items of Bruininks Long Form and 2 composites
14 items of Bruininks Short Form 2 composites (1st Admin.)
14 items of Bruininks Short Form 2 composites (2nd Admin.)
RS SS
RS SS
RS SS
30 APE students (19 boys, 11 girls)
30 NON-APE students (25 boys, 5 girls)
14 items of Bruininks Short Form 2 composites
6 items of Cornish Test 1 composite (1st Admin.)
6 items of Cornish Test 1 composite (2nd Admin.)
RS SS
PA
PA
10 students (9 boys, 1 girl)
20 students (16 boys, 4 girls)
11 students (9 boys, 2 girls)
19 students (14 boys, 5 girls)
60 non-disabled children (48 boys, 12 girls)
GROUP
1
2
3
LEARNING DISABLED
NORMALS

Figure 1
Conceptual Structure of Motor Performance
Data Used in This Study

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Federal guidelines for the protection of human subjects were followed in all aspects of the data collection process. This included approval by the Committee on Human Subjects Use at San Diego State University (Appendix A) and by the Board of Education of the Encinitas Union School District (Appendix B). In addition, parent permission was acquired for both the motor testing of all 120 subjects (Learning Disabled and Non Disabled) and the review of the IEP folders of the 60 Learning Disabled subjects (Appendix C). All tests were administered with caution and followed the procedures as stated in the respective test manuals (Bruininks, 1978; see Appendix D for Cornish Test description).

Data Collection Procedures

Due to a variety of reasons, including subjects having moved out of the area, only 21 of the Learning Disabled subjects from the May, 1982 study were available to be re-tested. These 21 subjects, 39 additional Learning Disabled children, and 60 Non Disabled students served as subjects in this investigation. All students were taken from elementary schools in the Encinitas Union School District.

The administration of the Bruininks-Oseretsky Short Form and the two administrations of the Cornish Test of Motor Planning were carried out in October and November, 1983 with the majority of the data collected the week of October 17 th, 1983. The testing was administered by Ms. Jan Patterson and Dr. Peter M. Aufsesser of the Project Staff, and Ms. Sara Stewart, a credentialed Adapted Physical Education Teacher currently teaching in another school district. All testing was conducted outdoors. Students were brought out in small groups which varied in size from two to six depending on the number of test administrators.

During administration of the motor performance tests, only one problem arose. Rope test B on the Cornish Test has an error score that can be utilized in the formula for calculating developmental age. Although the test originator decided not to use the error score in her procedure (Cornish, 1980), we wanted to have the score for possible use at a later time. During the first administration of the Cornish Test we noticed a discrepancy in the size of the error scores between test administrators. We decided to check the procedure and found that the protocol did indeed need modification. Thus, test scores for 78 subjects on the first administration of the Cornish test were redone so that the error score would be accurate and could thus be utilized at some point in the future. Administration of the Bruininks-Oseretsky Short Form was without problem.

Data from the IEP folders were retrieved by Dr. Aufsesser and Ms. Patterson in November, 1983 after all the motor performance data had been collected. (The data reported in these IEP's had been collected in April/May/June 1983.) Following a careful review of the files of the 60 Learning Disabled children, the following data were available for some of the subjects: PIAT (reading recognition; reading comprehension; spelling; math); WRAT (reading recognition; spelling; math); Beery Visual Motor test; Bruininks-Oseretsky Short Form test; Basic Motor Abilities test (6 items); and DIS speech placement status. The low number of scores on many of the tests, and their scattered pattern, made any use of these scores impracticable, however, and they were not considered in the remainder of the study.

Methods of Analysis

Data were analyzed using: (1) SPSSX (Statistical Package for the Social Sciences-X, Release 2.0 -- see SPSS Inc., 1983) to compute elementary descriptive statistics, standard inferential statistics (t-test, correlations, ANOVA), and to do the discriminant analysis; and (2) custom-made computer programs (developed by HAK) on an IBM-PC computer to conduct the various decision-validation analyses. These analyses were specifically those recommended by Berk (1976) including a classification of outcome probabilities analysis, a phi coefficient analysis, and a utility analysis. Because these procedures are not widely known, they are explained in brief outline in Appendix E.

FINDINGS

Data collected in October/November 1983 for each of the 120 students are shown in Appendix F. A key to the acronyms used for the variables is shown in Appendix G, Table 27. The original data that had been collected on the 21 "repeat" learning disabled students in May, 1982, together with essential parts of these subjects' October/November 1983 data, are shown in Appendix H. A key to the acronyms used for this data set is shown in Appendix I, Table 28.

Two major general types of statistical analysis were undertaken. The first type sought merely to describe general characteristics of the data in more succinct form, and to answer some rather general questions about the data sets which were seen as preliminary to the specific study questions described in detail earlier (pages 4-5). These general analyses are described below under the heading "General Analyses". The second type of analysis was focused on the specific study questions themselves; individual analyses of this second type are described under the heading "Specific Analyses", and are grouped in relation to the particular specific study questions they were designed to answer.

General Analyses

Students in each of the three groups -- Learning Disabled - APE, Learning Disabled - No APE, and Non-Disabled -- were chosen on the basis of their availability for testing. It was therefore thought important that general characteristics of the three groups should be similar if we were to make inferences about group differences. The numbers of males/females in the three groups were 25/5, 23/7, and 48/12. (The much larger proportion of males in each group reflects the fact that many more boys than girls are identified as learning disabled in the general population.)

The differences in the mean age of each group were tested using one-way analysis of variance. These differences were found to be not significant (Table 3), thus suggesting that covariate adjustment in later analyses was unnecessary.

As noted earlier (Study Approach (1)), 21 of the 60 students in Groups 1 and 2 had been previously measured on the Bruininks Short Form Test in May 1982. Ten of these students (9 boys, 1 girl) were in Group 1, thus 16 boys and 4 girls were "new" subjects. Similarly, 11 (9 boys, 2 girls) of the students in Group 2 had contributed data in May '82, and thus 14 boys and 5 girls in this Group were "new" subjects. These numerical divisions are shown in diagrammatic form in Figure 1.

Table 3

Analysis of Variance Comparing Means of Three Groups on Age

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN	2	2907.30	1453.65	2.6690	0.0735
WITHIN	117	63723.20	544.64		
TOTAL	119	66630.50			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR
GRP 1	30	110.5000	28.2413	5.1561
GRP 2	30	124.3000	15.1752	2.7706
GRP 3	60	116.1000	23.9758	3.0953
TOTAL	120	116.7500	23.6626	2.1601

Tests for homogeneity of variances

COCHRANS C = .4976, P = .016
BARTLETT-BOX F = 5.293 , P = .005

Results of Newman-Keuls Follow-up Test

- NO TWO GROUPS ARE SIGNIFICANTLY DIFFERENT AT THE 0.050 LEVEL

General descriptive statistics for all variables are shown in Appendix J, Table 29. Tables 30 through 32 of Appendix J show the descriptive statistics for each of the three assignment groups separately -- Learning Disabled students assigned to APE (Table 30), Learning Disabled students not assigned to APE (Table 31), and Non-Disabled students (Table 32).

Confirmation was sought that the three assignment groups did actually differ on the 4 decision tests (Bruininks-Oseretsky Short Form Raw Score, Bruininks-Oseretsky Short Form Standard Score, Cornish % of Develomental Age (Administration 1), and Cornish % of Developmental Age (Administration 2)). Such confirmation is a necessary preliminary to having faith that the tests might indeed be useful in discriminating children with different placement needs. Analyses of variance for all four measures did make this confirmation (Tables 4, 5, 6, 7).

Table 4

Analysis of Variance Comparing Means of Three Groups on Bruininks Raw Score

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN	2	25428.68	12714.337	60.06	0.0
WITHIN	117	24766.25	211.677		
TOTAL	119	50194.93			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR
GRP 1	30	28.5667	17.3019	3.1589
GRP 2	30	61.7000	9.0331	1.6492
GRP 3	60	62.4167	15.2486	1.9686
TOTAL	120	53.7750	20.5379	1.8748

Tests for homogeneity of variances

COCHRANS C = .4880, P = .024
BARTLETT-BOX F = 5.953 , P = .003

Results of Newman-Keuls Follow-up test

MEAN	GROUP	G R P 1	G R P 2	G R P 3
28.5667	GRP 1			
61.7000	GRP 2	*		
62.4167	GRP 3	*		

(*) DENOTES PAIRS OF GROUPS SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL

Table 5

Analysis of Variance Comparing Means of Three Groups on Bruininks Standard Score

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN	2	20897.65	10448.83	79.77	0.0
WITHIN	117	15325.02	130.98		
TOTAL	119	36222.67			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR
GRP 1	30	30.2333	10.4772	1.9129
GRP 2	30	54.2000	11.6246	2.1223
GRP 3	60	62.4500	11.8055	1.5241
TOTAL	120	52.3333	17.4468	1.5927

Tests for homogeneity of variances

COCHRANS C = .3627, P = .927
BARTLETT-BOX F = .275 , P = .760

Results of Newman-Keuls Follow-up Test

MEAN	GROUP	G R P 1	G R P 2	G R P 3
30.2333	GRP 1			
54.2000	GRP 2	*		
62.4500	GRP 3	*	*	

(*) DENOTES PAIRS OF GROUPS SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL

Table 6

Analysis of Variance Comparing Means of Three Groups on Cornish % of Developmental Age Score (Administration 1)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN	2	90972.10	45486.05	59.95	0.0
WITHIN	117	88776.40	758.77		
TOTAL	119	179748.50			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR
GRP 1	30	51.7667	34.9726	6.3851
GRP 2	30	110.9000	18.8302	3.4379
GRP 3	60	117.1667	27.0042	3.4862
TOTAL	120	99.2500	38.8650	3.5479

Tests for homogeneity of variances

COCHRANS C = .5302, P = .003
BARTLETT-BOX F = 5.215 , P = .006

Results of Newman-Keuls Follow-up Test

MEAN	GROUP	G R P 1	G R P 2	G R P 3
51.7667	GRP 1			
110.9000	GRP 2	*		
117.1667	GRP 3	*		

(*) DENOTES PAIRS OF GROUPS SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL

Table 7

Analysis of Variance Comparing Means of Three Groups on Cornish % of Developmental Age Score (Administration 2)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN	2	87412.68	43706.34	61.92	0.0
WITHIN	117	82587.68	705.88		
TOTAL	119	170000.37			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR
GRP 1	30	58.3000	37.0286	6.7605
GRP 2	30	115.6000	19.2615	3.5167
GRP 3	60	122.6167	23.3130	3.0097
TOTAL	120	104.7833	37.7965	3.4503

Tests for homogeneity of variances

COCHRANS C = .5999, P = .000
BARTLETT-BOX F = 7.321 , P = .001

Results of Newman-Keuls Follow-up Test

MEAN	GROUP	GRP 1	GRP 2	GRP 3
58.3000	GRP 1			
115.6000	GRP 2	*		
122.6167	GRP 3	*		

(*) DENOTES PAIRS OF GROUPS SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL

Specific Analyses

The particular analyses that were used to answer the specific study questions referred to earlier will be described in specific relation to each question.

Question 1: To what extent is the Bruininks-Oseretsky Short Form test valid in the specific terms of its successfulness in making correct decisions about the assignment of children to Adapted Physical Education? To what extent does this successfulness differ for a heterogeneous ("mixed") population (containing both Non Disabled and Learning Disabled children) and a population containing only Learning Disabled children? How should test scores best be used to lead to correct assignment decisions?

To answer these questions, decision validation analyses were conducted for the entire group of 120 students, and for the 2 sub-groups of Learning Disabled students alone. Several indices were calculated to determine the successfulness in making proper assignment of students based on particular "cutting scores" on the Bruininks Short Form Test (i.e. the decision test) -- the C coefficient, the (Phi, ϕ) coefficient, and 3 variants of the (Psi, ψ) coefficient. All of these coefficients attempt to convey the success with which the decision test correctly chooses proper assignment (True Masters (TM) and True Non Masters (TNM)) as opposed to improper assignment (False Negatives (FN) and False Positives (FP)).

Table 8 shows these coefficients for a range of cutting scores between 25 and 50 for the entire sample of students. It is noted that a cutting score of 40 yields the best discrimination, only 10 of the 120 students (8.33%) being mis-classified using this criterion alone. The pattern of superiority is shown across four of the five coefficients examined (C, ϕ, ψ_b, ψ_c), their maximal value being attained at this cutting point.

In Table 9, the same analysis is made for the Bruininks Short Form Test for the Learning Disabled students alone. Again, and a little more noticeably, the cutting score of 40 gives the best assignment discrimination. In this case,, 7 of 60 students (11.67%) were misclassified using this criterion alone. This demonstrates that the test maintains a good level of validity even when applied to a restricted (and therefore more homogeneous) group.

Although the cutting score of 40 seems fairly well defined as the "best" cutting score, it can be seen that the test still remains a fairly accurate discriminator with other scores close to this value. Suitable scores seem to "plateau" in the range 33 to 41 and there seems little loss of precision in using any of the scores in this range as the practical cutting score.

Table 8

Decision Validity Coefficients for Different Cutting Scores on the Bruininks-Oseretsky Short Form Test (Standard Score) for All Students

Cutting Score	TA | FNA / FA | TNA	C	ϕ	ψ_a	ψ_b	ψ_c	S's wrongly assigned to APE / S's not assigned to APE
45	81 | 9 / 4 | 26	.892	.730	85	90	116	32 39 42 50 52 59 62 76 109 / 16 17 23 27
44	81 | 9 / 4 | 26	.892	.730	85	90	116	32 39 42 50 52 59 62 76 109 / 16 17 23 27
43	82 | 8 / 5 | 25	.892	.722	86	89	114	32 39 42 52 59 62 76 109 / 5 16 17 23 27
42	83 | 7 / 5 | 25	.900	.740	89	91	116	32 39 52 59 62 76 109 / 5 16 17 23 27
41	84 | 6 / 5 | 25	.908	.758	92	93	118	32 39 52 62 76 109 / 5 16 17 23 27
40	85 | 5 / 5 | 25	.917	.778	95	95	120	32 52 62 76 109 / 5 16 17 23 27
39	85 | 5 / 6 | 24	.908	.753	93	92	116	32 52 62 76 109 / 5 15 16 17 23 27
38	86 | 4 / 7 | 23	.908	.749	94	91	114	32 52 76 109 / 5 14 15 16 17 23 27
37	86 | 4 / 7 | 23	.908	.749	94	91	114	32 52 76 109 / 5 14 15 16 17 23 27
36	86 | 4 / 7 | 23	.908	.749	94	91	114	32 52 76 109 / 5 14 15 16 17 23 27
35	87 | 3 / 7 | 23	.917	.771	97	93	116	52 76 109 / 5 14 15 16 17 23 27
34	87 | 3 / 8 | 22	.917	.771	97	93	116	52 76 109 / 5 14 15 16 17 23 27
33	87 | 3 / 8 | 22	.917	.771	97	93	116	52 76 109 / 5 14 15 16 17 23 27
30	88 | 2 / 10 | 20	.900	.721	94	86	106	76 109 / 5 9 14 15 16 17 18 23 25 27
25	88 | 2 / 11 | 19	.892	.696	92	83	102	76 109 / 5 9 14 15 16 17 18 23 25 27 28

Table 9

Decision Validity Coefficients for Different Cutting Scores on the Bruininks-Oseretsky Short Form Test (Standard Score) for Learning Disabled Students)

Cutting Score	TA | FNA / FA | TNA	C	ϕ	ψ_a	ψ_b	ψ_c	S's wrongly assigned to APE S's not assigned to APE
46	22 | 8 / 4 | 26	.800	.605	28	32	58	32 39 41 42 45 50 52 59 16 17 23 27
45	24 | 6 / 4 | 26	.883	.668	34	36	62	32 39 42 50 52 59 16 17 23 27
44	24 | 6 / 4 | 26	.883	.668	34	36	62	32 39 42 50 52 59 16 17 23 27
43	25 | 5 / 5 | 25	.883	.667	35	35	60	32 39 42 52 59 5 16 17 23 27
42	26 | 4 / 5 | 25	.850	.700	38	37	62	32 39 52 59 5 16 17 23 27
41	27 | 3 / 5 | 25	.867	.735	41	39	64	32 39 52 5 16 17 23 27
40	28 | 2 / 5 | 25	.883	.771	44	41	66	32 52 5 16 17 23 27
39	27 | 3 / 5 | 25	.867	.735	41	39	64	32 39 52 5 16 17 23 27
38	28 | 2 / 7 | 23	.850	.710	50	35	58	32 52 5 14 15 16 17 23 27
37	28 | 2 / 7 | 23	.850	.710	50	35	58	32 52 5 14 15 16 17 23 27
36	28 | 2 / 7 | 23	.850	.710	50	35	58	32 52 5 14 15 16 17 23 27
35	29 | 1 / 7 | 23	.867	.748	43	37	60	52 5 14 15 16 17 23 27
34	29 | 1 / 7 | 23	.867	.748	43	37	60	52 5 14 15 16 17 23 27
33	29 | 1 / 7 | 23	.867	.748	43	37	60	52 5 14 15 16 17 23 27
30	30 | 0 / 10 | 20	.833	.707	40	30	50	5 9 14 15 16 17 18 23 25 27
25	30 | 0 / 11 | 19	.817	.618	38	27	46	5 9 14 15 16 17 18 23 25 27

Question 2: To what extent are Bruininks-Oseretsky test scores consistent (in the decision sense) over a period of 17 months? (Note that this can be answered only relative to Learning Disabled students.) Are the early scores good predictors of what time shows a child's motor outcomes to become?

Two approaches can be taken to examining the consistency of Bruininks-Oseretsky test scores over the 17 month period during which we collected data. One approach, the traditional one, is to examine Pearson correlation coefficients between sets of scores taken at the beginning and end of the period. Table 10 shows the intercorrelations between relevant scores taken in May, 1982 and October/November, 1983. It is noted that the correlations between the two sets of Bruininks-Oseretsky scores taken 17 months apart are .77 and .79. A second piece of evidence that the long-term reliability of the Short Form test is sound is that the October/November test scores correlated .90 with the May 1982 Long Form scores.

Another aspect that must considered in a traditional framework of reliability concerns whether test scores appear to improve over time. Three dependent t-tests were conducted to ascertain whether Short Form scores improved from one administration time to another during the period considered (Table 11). It is noted that although scores improved significantly in the one week from first to second test administration in May 1982 (presumably due to test wiseness), no long-term improvement over the 17-month period was noted.

A second approach that can be taken to reliability determination is that derived from the decision framework. In this approach, our concern is on how interpretation of the May 1982 test scores would lead to the same decisions that had been reached 17 months later in October/November 1983. In making this analysis we had to take account of the fact that the APE assignment of some children may have changed in the interim -- perhaps, in fact, because of the improvements they had made through being in the APE program. Such a change of status had in fact happened for 5 of the 21 "repeat" students that we followed. (Full data is shown in Appendix H.)

The small amount of data that could be collected by us, and the complications caused by changes in assignment status (as noted above), made a formal decision analysis inappropriate. However, it was noted that if a cutting score of 40 had been used to make a APE decision assignment from the May 1982 Bruininks Short Form data, only 2 of the 21 students considered would have been mis-classified based on the known October/November 1983 assignment. This certainly provides positive evidence that Bruininks-Oseretsky Test scores have a good level of reliability, even over a rather long period.

Table 10

Correlations between Bruininks-Oseretsky Test Scores Taken in May 1982, and Cornish Test and Bruininks-Oseretsky Test Scores Taken in October/November 1983 for 21 Learning Disabled Children

	BLS	BSS1	BSS2	BSS3	CPAGE1	CPAGE2
BLS	1.00	.90	.88	.90	.74	.65
	(0)	(21)	(21)	(21)	(21)	(21)
	P= .	P= .00	P= .00	P= .00	P= .00	P= .00
BSS1	.90	1.00	.93	.77	.69	.61
	(21)	(0)	(21)	(21)	(21)	(21)
	P= .00	P= .	P= .00	P= .00	P= .00	P= .00
BSS2	.88	.93	1.00	.79	.75	.77
	(21)	(21)	(0)	(21)	(21)	(21)
	P= .00	P= .00	P= .	P= .00	P= .00	P= .00
BSS3	.90	.77	.79	1.00	.70	.61
	(21)	(21)	(21)	(0)	(21)	(21)
	P= .00	P= .00	P= .00	P= .	P= .00	P= .00
CPAGE1	.74	.69	.75	.70	1.00	.79
	(21)	(21)	(21)	(21)	(0)	(21)
	P= .00	P= .00	P= .00	P= .00	P= .	P= .00
CPAGE2	.65	.61	.77	.61	.79	1.00
	(21)	(21)	(21)	(21)	(21)	(0)
	P= .00	P= .00	P= .00	P= .00	P= .00	P= .

BLS -- Bruininks-Oseretsky Long Form Scores taken May '82
BSS1 -- Bruininks-Oseretsky Short Form Scores taken May '82
BSS2 -- Bruininks-Oseretsky Short Form Scores taken one week following BSS1
BSS3 -- Bruininks-Oseretsky Short Form Scores taken October/November 1983
CPAGE1 -- Cornish % Developmental Age Scores, taken October/November 1983
CPAGE2 -- Cornish % Developmental Age Scores, taken one week following CPAGE1

Table 11

Comparison of Group Mean Scores on Bruininks-Oseretsky Short Form Test Taken At Three Different Times for 21 Learning Disabled Children

VAR	MEAN	N	STD DEV	t	df	PROB 2-TAIL
BSS1	37.57	21	14.26	-2.74	20	0.013
BSS2	41.14	21	16.45			
BSS1	37.57	21	14.26	-1.88	20	0.075
BSS3	42.38	21	18.47			
BSS2	41.14	21	16.45	-0.50	20	0.624
BSS3	42.38	21	18.47			

BSS1 -- Bruininks-Oseretsky Short Form Score taken May '82
BSS2 -- Bruininks-Oseretsky Short Form Score taken one week following BSS1
BSS3 -- Bruininks-Oseretsky Short Form Score taken October/November 1983

Question 3: To what extent is the Cornish Test of Motor Planning successful in predicting correct decisions about the assignment of children to Adapted Physical Education? Is its successfulness and appropriateness dependent on whether it is assessing a mixed population of children, or Learning Disabled children only? How should test scores best be used to lead to correct assignment decisions?

A preliminary question that must be addressed here is whether performance on the Cornish Test improved between the first and second administrations. This was determined for each group separately, and for the total group, by conducting t tests between group means for first and second administrations. The results of these t tests are shown in Table 12. It is seen that there is a significant increase in mean scores for all three groups, suggesting an appreciable "learning factor" in doing the Cornish test. This consideration makes it clear that the present question cannot be answered independently of Question 4 below, nevertheless we will maintain the division of interest in examining issues related to the Cornish Test.

The same types of analyses conducted to answer Question 1 were made to answer the questions noted under Question 3. Tables 13 and 14 show, for different cutting scores, the various decision validity coefficients descriptive of the Cornish test's successfulness in predicting correct APE assignment for the mixed population of children (i.e. for Learning Disabled and Non-Disabled); Table 13 examines scores from the first administration of the Cornish Test, Table 14 scores from its second administration.

The most successful cutting score for the Cornish test appears to be a % Developmental Age score of 91 or 92% though a central point of best precision for Learning Disabled students might be 2 or 3 percentage points higher. In examining these Tables one notices several features which invite comparison of to those obtained for the Bruininks-Oseretsky Test (as described under Question 1). First, the Cornish Test appears slightly less successful than the Bruininks-Oseretsky Test; in its best discrimination, 12 of the 120 students were misclassified (10.0%). This is not much poorer than the Bruininks-Oseretsky's successfulness. Second, as with the Bruininks-Oseretsky, a fairly wide range of scores defined a good level of discrimination -- generally the approximate range 85% to 92% of developmental age.

Decision validation coefficients for the Cornish Test for Learning Disabled children alone are shown in Tables 15 (first administration) and 16 (second administration). The discrimination is equal to that of the Bruininks- Oseretsky Test, its best level of accuracy occurring with 7 of the 60 students misclassified (11.67%).

Table 12

Comparison of Means of First and Second Cornish Test Scores for Each of Three Groups and the Total Group

Group	N	Mean Admin 1	Mean Admin 2	t	2-Tail Prob
1 Learning Disabled, with APE	30	51.77	58.30	-2.22	0.034
2 Learning Disabled, no APE	30	110.90	115.60	-2.28	0.030
3 Non-Disabled	60	117.17	122.62	-2.83	0.006
Total	120	99.25	104.78	-4.23	0.000

Table 13

Decision Validity Coefficients for Different Cutting Scores on the Cornish & Developmental Age Score (Admin. 1), All Students

Cutting Score	TA | FNA / FA | TNA	C	ϕ	ψ_a	ψ_b	ψ_c	S's wrongly assigned to APE / S's not assigned to APE
80	84 | 6 / 11 | 19	.858	.604	80	75	94	not shown
86	81 | 9 / 5 | 25	.883	.705	83	87	112	32 50 57 59 72 76 87 88 109 / 14 16 25 27 30
87	81 | 9 / 5 | 25	.883	.705	83	87	112	32 50 57 59 72 76 87 88 109 / 14 16 25 27 30
88	81 | 9 / 5 | 25	.883	.705	83	87	112	32 50 57 59 72 76 87 88 109 / 14 16 25 27 30
89	81 | 9 / 5 | 25	.883	.705	83	87	112	32 50 57 59 72 76 87 88 109 / 14 16 25 27 30
90	81 | 9 / 5 | 25	.883	.705	83	87	112	32 50 57 59 72 76 87 88 109 / 14 16 25 27 30
91	80 | 10 / 5 | 25	.875	.688	80	85	110	32 50 57 59 72 76 82 87 88 109 / 14 16 25 27 30
92	80 | 10 / 4 | 26	.833	.714	82	88	114	32 50 57 59 72 76 82 87 88 109 / 16 25 27 30
93	78 | 12 / 3 | 27	.875	.709	78	87	114	32 50 52 57 59 72 76 82 87 88 96 109 / 16 27 30
94	77 | 13 / 2 | 28	.875	.720	77	88	116	32 50 52 57 59 72 76 82 87 88 96 109 110 / 27 30
95	76 | 14 / 2 | 28	.867	.706	74	86	114	not shown
96	75 | 15 / 2 | 28	.858	.692	71	84	112	not shown

Table 14

Decision Validity Coefficients for Different Cutting Scores on the Cornish % Developmental Age Score (Admin. 2), All Students

Cutting Score	TA | FNA / FA | TNA	C	ϕ	ψ_a	ψ_b	ψ_c	S's wrongly assigned to APE / S's not assigned to APE
85	86 | 4 / 9 | 21	.892	.699	90	85	106	51 72 76 109 / 7 12 14 16 20 23 25 27 30
86	86 | 4 / 9 | 21	.892	.699	90	85	106	51 72 76 109 / 7 12 14 16 20 23 25 27 30
87	85 | 5 / 9 | 21	.883	.677	87	83	104	51 72 76 109 115 / 7 12 14 16 20 29 23 25 27 30
88	85 | 5 / 8 | 22	.892	.703	89	86	108	51 72 76 109 115 / 12 14 16 20 23 25 27 30
89	85 | 5 / 8 | 22	.892	.703	89	86	108	51 72 76 109 115 / 12 14 16 20 23 25 27 30
90	85 | 5 / 8 | 22	.892	.703	89	86	108	51 72 76 109 115 / 12 14 16 20 23 25 27 30
91	85 | 5 / 7 | 23	.900	.728	91	89	112	51 72 76 109 115 / 12 14 16 23 25 27 30
92	85 | 5 / 7 | 23	.900	.728	91	89	112	51 72 76 109 115 / 12 14 16 23 25 27 30
93	81 | 9 / 7 | 23	.867	.653	79	81	104	32 51 59 72 76 82 87 109 115 / 12 14 16 23 25 27 30
94	79 | 11 / 7 | 23	.850	.619	73	77	100	32 39 51 59 72 76 82 87 96 109 115 / 12 14 16 23 25 27 30
95	78 | 12 / 6 | 24	.850	.630	72	78	102	32 39 51 59 72 76 82 87 88 96 109 115 / 12 14 16 23 25 27
96	78 | 12 / 6 | 24	.850	.630	72	78	102	32 39 51 59 72 76 82 87 88 96 109 115 / 12 14 16 23 25 27

Table 15

Decision Validity Coefficients for Different Cutting Scores on the Cornish & Developmental Age Score (Admin. 1), Learning Disabled Students

Cutting Score	TA | FNA / FA | TNA	C	ϕ	ψ_a	ψ_b	ψ_c	S's wrongly assigned to APE / S's not assigned to APE
80	29 | 1 / 11 | 19	.800	.636	35	25	44	59 / 3 7 12 14 16 17 20 23 25 27 30
85	26 | 4 / 6 | 24	.833	.668	36	34	58	32 50 57 59 / 14 16 20 25 27 30
90	26 | 4 / 5 | 25	.850	.700	38	37	62	32 50 57 59 / 14 16 25 27 30
91	26 | 4 / 5 | 25	.850	.700	38	37	62	32 50 57 59 / 14 16 25 27 30
92	26 | 4 / 4 | 26	.867	.733	40	40	66	32 50 57 59 / 16 25 27 30
93	25 | 5 / 3 | 27	.867	.735	39	41	68	32 50 52 57 59 / 16 27 30
94	25 | 5 / 2 | 28	.883	.771	41	44	72	32 50 52 57 59 / 27 30
95	25 | 5 / 2 | 28	.883	.771	41	44	72	32 50 52 57 59 / 27 30
96	25 | 5 / 2 | 28	.883	.771	41	44	72	32 50 52 57 59 / 27 30
100	21 | 9 / 1 | 29	.833	.692	31	39	68	32 39 41 50 51 52 53 57 59 / 27

Table 16

Decision Validity Coefficients for Different Cutting Scores on the Cornish % Developmental Age Score (Admin. 2), Learning Disabled Students

Cutting Score	TA | FNA / FA | TNA	C	ϕ	ψ_a	ψ_b	ψ_c	S's wrongly assigned to APE / S's not assigned to APE
86	29 | 1 / 9 | 21	.833	.692	39	31	52	51 / 7 12 14 16 20 23 25 27 30
87	29 | 1 / 9 | 21	.833	.692	39	31	52	51 / 7 12 14 16 20 23 25 27 30
88	29 | 1 / 8 | 22	.850	.720	39	31	52	51 / 12 14 16 20 23 25 27 30
89	29 | 1 / 8 | 22	.850	.720	39	31	52	51 / 12 14 16 20 23 25 27 30
90	29 | 1 / 8 | 22	.850	.720	41	34	56	51 / 12 14 16 20 23 25 27 30
91	29 | 1 / 7 | 23	.867	.748	43	37	60	51 / 12 14 16 23 25 27 30
92	29 | 1 / 7 | 23	.867	.748	43	37	60	51 / 12 14 16 23 25 27 30
93	27 | 3 / 7 | 23	.833	.673	37	33	56	32 51 59 / 12 14 16 23 25 27 30
94	26 | 4 / 7 | 23	.817	.637	34	31	54	32 39 51 59 / 12 14 16 23 25 27 30
95	26 | 4 / 6 | 24	.833	.668	36	34	58	32 39 51 59 / 12 14 16 23 25 27
96	26 | 4 / 6 | 24	.833	.668	36	34	58	32 39 51 59 / 12 14 16 23 25 27
100	24 | 6 / 5 | 25	.817	.634	32	33	58	32 39 48 51 53 59 / 12 14 16 25 27

Question 4 : Is the Cornish Test of Motor Planning sufficiently reliable (in the sense of consistent decision) for use with either a mixed population of children or with Learning Disabled students only? To what extent can alternative test interpretation procedures (i.e. different cutting scores) affect the reliability?

From a traditional reliability standpoint, the Cornish Test of Motor Planning was found to be very satisfactory. The correlation between the composite % Developmental Age scores for the first and second administrations to the entire group was 0.931. For the Learning Disabled - APE, the Learning Disabled - No APE, and the Non-Disabled groups alone, respective reliability coefficients were 0.901, 0.824, and 0.834. The magnitudes of these coefficients are all sufficiently high to give confidence in the instrument.

From a decision consistency standpoint, the test was found to be much less satisfactory. For the total group of students, and adopting a cutting score of 92, 14 students were mis-classified on the first administration, and 12 on the second administration. However, though the number of mis-classified students is close, the specific students varied markedly. A conceptual, and non-rigorous illustration of this idea may be seen by reference to Tables 13 and 14, since the final column of each table lists the identification numbers of each student mis-classified. Of the 14 students mis-classified by the first administration of the Cornish test, only 7 were mis-classified by the second administration of the test.

A more formal view of this kind of unreliability is afforded by use of the methods of Swaminathan, Hambleton, and Algina (1974). In the formulation of these authors, reliability in the decision framework is obtained from the fourfold decision table. The results of such an analysis are shown in Table 17 for the case in which a cutting score of 92 was used as the basis for assignment for both administrations of the Cornish Test. As shown in the Table, the Cohen Kappa reliability resulting from this analysis is 0.75.

Table 17

A Decision Reliability Analysis of the Cornish Test for the Total Group

Cutting Score on First Administration = 92
Cutting Score on Second Administration = 92

FOURFOLD TABLE

		Test 2 Decision: Don't Assign to APE	Test 2 Decision: Assign to APE
Test 1 Decision	Don't Assign to APE	82	2
	Assign to APE	10	26

Cohens Kappa = 0.750
ϕ coefficient = 0.757

FNA (False Non-Acceptance) Subjects
51 115

FA (False Acceptance) Subjects
12 14 23 32 50 57 59 82 87 88

(Output taken from a computer program by H.A.King)

Question 5 : Do either the Bruininks-Oseretsky Short Form or the Cornish Motor Planning Test seem superior for the purpose of identifying children in need of Adapted Physical Education? Does this superiority differ for mixed populations of children and Learning Disabled children? Can the tests be used conjointly to lead to more accurate decision making?

As noted earlier, both the Bruininks-Oseretsky Test and the Cornish Test used alone are strong predictors of a child's need for Adapted Physical Education service. The data presented indicate that the Bruininks-Oseretsky Test is slightly the better of the two relative to its successfulness in predicting correct decision for a mixed (heterogeneous) population of children; however, for learning disabled children alone, both tests seem equally effective.

Since both tests are fairly good predictors, it seems natural to wonder whether the two used in combination could afford a yet more accurate (i.e. valid) means of ascertaining a child's APE assignment status. An obvious preliminary question to such a consideration concerns the extent to which the two tests agree. As earlier, we may proceed within a traditional correlational framework or within a decision consistency framework.

To answer the question in the correlational framework, intercorrelations were computed between the two Bruininks-Oseretsky composites (Raw and Standard) and the Cornish Test composite for both first and second test administrations. Results for the total (heterogeneous) group are shown in Table 18. Results for the three sub-groups -- Learning Disabled - APE, Learning Disabled - No APE, and Non-Disabled -- are shown in Tables 19 through 21. Correlations for the total group are seen to be in the moderate range. For the two Learning Disabled groups, however, the correlations are very low. This apprises us to the fact that agreement between the Bruininks-Oseretsky and Cornish tests is largely an artifact of applying their use to heterogeneous populations. Clearly, the tests measure rather different motor skills.

The lack of agreement between the tests would seem to augur well for the usefulness of combining them as predictors of a child's APE assignment status. A discriminant analysis was conducted to determine how well assignment status could be predicted from an optimal combination of the two test scores. Such an analysis serves as a kind of "bridge" between a strictly correlational approach and a decision-analytic approach because it utilizes correlation/regression principles to arrive at a categorical classification.

Table 18

Correlations Between Test Scores for Total Group (N=120)

	BRRS	BRSS	CPAGE1	CPAGE2
BRRS	1.0000	.8004	.8313	.8093
	(0)	(120)	(120)	(120)
	P= .	P= .000	P= .000	P= .000
BRSS	.8004	1.0000	.7442	.7437
	(120)	(0)	(120)	(120)
	P= .000	P= .	P= .000	P= .000
CPAGE1	.8313	.7442	1.0000	.9305
	(120)	(120)	(0)	(120)
	P= .000	P= .000	P= .	P= .000
CPAGE2	.8093	.7437	.9305	1.0000
	(120)	(120)	(120)	(0)
	P= .000	P= .000	P= .000	P= .

BRRS -- Bruininks-Oseretsky Raw Score (Composite)
BRSS -- Bruininks-Oseretsky Standard Score (Composite)
CPAGE1 -- Cornish % Developmental Age score, Admin. 1
CPAGE2 -- Cornish % Developmental Age score, Admin. 2

Table 19

Correlations Between Test Scores, Learning Disabled - APE Students (N=30)

	BRRS	BRSS	CPAGE1	CPAGE2
BRRS	1.0000 (0) P= .	.5361 (30) P= .001	.8634 (30) P= .000	.8387 (30) P= .000
BRSS	.5361 (30) P= .001	1.0000 (0) P= .	.3772 (30) P= .020	.4062 (30) P= .013
CPAGE1	.8634 (30) P= .000	.3772 (30) P= .020	1.0000 (0) P= .	.9013 (30) P=0.0
CPAGE2	.8387 (30)	.4062 (30)	.9013 (30)	1.0000 (0)

BRRS -- Bruininks-Oseretsky Raw Score (Composite)
BRSS -- Bruininks-Oseretsky Standard Score (Composite)
CPAGE1 -- Cornish % Developmental Age score, Admin. 1
CPAGE2 -- Cornish % Developmental Age score, Admin. 2

Table 20

Correlations Between Test Scores, Learning Disabled - No APE Students (N=30)

	BRRS	BRSS	CPAGE1	CPAGE2
BRRS	1.0000 (0) P= .	.7276 (30) P= .000	.3651 (30) P= .024	.1444 (30) P= .223
BRSS	.7276 (30) P= .000	1.0000 (0) P= .	.4984 (30) P= .003	.2797 (30) P= .067
CPAGE1	.3651 (30) P= .024	.4984 (30) P= .003	1.0000 (0) P= .	.8239 (30) P= .000
CPAGE2	.1444 (30) P= .223	.2797 (30) P= .067	.8239 (30) P= .000	1.0000 (0) P= .

BRRS -- Bruininks-Oseretsky Raw Score (Composite)
BRSS -- Bruininks-Oseretsky Standard Score (Composite)
CPAGE1 -- Cornish % Developmental Age score, Admin. 1
CPAGE2 -- Cornish % Developmental Age score, Admin. 2

Table 21

Correlations Between Test Scores, Non-Disabled Students (N=60)

	BRRS	BRSS	CPAGE1	CPAGE2
BRRS	1.0000	.6301	.5782	.5474
	(0)	(60)	(60)	(60)
	P= .	P= .000	P= .000	P= .000
BRSS	.6301	1.0000	.5248	.5989
	(60)	(0)	(60)	(60)
	P= .000	P= .	P= .000	P= .000
CPAGE1	.5782	.5248	1.0000	.8340
	(60)	(60)	(0)	(60)
	P= .000	P= .000	P= .	P= .000
CPAGE2	.5474	.5989	.8340	1.0000
	(60)	(60)	(60)	(0)
	P= .000	P= .000	P= .000	P= .

BRRS -- Bruininks-Oseretsky Raw Score (Composite)
BRSS -- Bruininks-Oseretsky Standard Score (Composite)
CPAGE1 -- Cornish % Developmental Age score, Admin. 1
CPAGE2 -- Cornish % Developmental Age score, Admin. 2

Results of this analysis are shown in Table 22. The optimal linear combination of the Bruininks-Oseretsky and Cornish test scores yielded a percentage of correct classifications of 90%, that is, a percentage of mis-classifications of 10%. This is a curious, and at first glance paradoxical fact. As noted earlier, (in discussion of the findings related to Question 1), the mis-classification rate using the Bruininks-Oseretsky test alone was 8.33%, and thus we see that classification accuracy became poorer using the optimal combination of two tests! The explanation lies in the fact that a discriminant analysis optimizes NOT classification accuracy, but the separation of group means, and for non-normal distributions, improvement in one does not necessarily lead to improvements in the other.

We next investigated what the effect would be if we combined the results of the Bruininks-Oseretsky and Cornish tests within a decision framework. The effects on decision accuracy of using the two decision tests in tandem were studied. The rationale of the methods used is explained in Appendix E, section "Joint Use of Decision Variables".

Two analyses for the 2-decision-test case are shown in Tables 23 and 24. Table 23 shows results for using the Bruininks-Oseretsky and Cornish Test (Administration 1) scores conjointly, and Table 24 those using the Bruininks-Oseretsky and Cornish Test (Administration 2) scores conjointly. In both cases the analysis was conducted for the total group of Learning Disabled and Non-Disabled students. In both cases, we examined the single cutting score of 40 on the Bruininks-Oseretsky Test (a value which discriminated well when this test was used as a single decision variable) combined with cutting scores of 91, 92, and 93 on the Cornish Test composite. Values of the 5 classification success indices are shown for each combination of values and for both the strong and weak inference cases as defined earlier.

There is no clear sign that using two decision variables improved classification accuracy better than had been found for a single decision variable: the best classification accuracy found in these two Tables is 91.7%, or a mis-classification rate of 8.3% (i.e. 10 mis-classifications from 120 students). Comparison of these two particular cases -- 40,92 cutting score combination in Table 23, and 40 cutting score in Table 8 -- reveals that though the number of mis-classified students was the same, the actual persons mis-classified altered somewhat.

Another point worthy of note in Tables 23 and 24 is that the utility coefficients ( ) varied considerably depending on whether strong or weak inference decision tactics were being used. As would be expected from the logical underpinnings of each of the indices, ψ_a(Weak) is generally greater than ψ_a(Strong), and ψ_c(Weak) is generally less than ψ_c(Strong).

Table 22

Discriminant Analysis to Predict APE Assignment Status from Bruininks-Oseretsky and Cornish Test Scores

Standardized Canonical Discriminant Function Coefficients

	FUNCN 1
BRSS	0.63326
CPAGE1	0.52781

Classification results

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP 2 NO APE	1 APE
GROUP 2 NO APE	90	82 91.1%	8 8.9%
GROUP 1 LEARN DIS WITH APE	30	4 13.3%	26 86.7%

% OF "GROUPED" CASES CORRECTLY CLASSIFIED: 90.00%

Subjects mis-classified

FNA (False Non-Acceptance) Subjects (N=8)
32 39 50 52 59 72 76 109

FA (False Acceptance) Subjects (N=4)
16 17 23 27

Table 23

Decision Validity Coefficients Using Both Bruininks and Cornish Test (Administration 1) Scores to Predict APE Assignment

Inference Type	Cutting Scores	TA FNA / FA TNA	C	ϕ	ψ_a	ψ_b	ψ_c	S's wrongly assigned to APE / S's not assigned to APE
ST	40, 91	78 | 12 / 2 | 28	.883	.735	80	90	118	32 50 52 57 59 62 72 76 82 87 88 109 / 16 27
WE	40, 91	87 | 3 / 8 | 22	.908	.746	95	90	112	32 76 109 / 5 14 16 17 23 25 27 30
ST	40, 92	78 | 12 / 2 | 28	.883	.735	80	90	118	32 50 52 57 59 62 72 76 82 87 88 109 / 16 27
WE	40, 92	87 | 3 / 7 | 23	.917	.771	97	93	116	32 76 109 / 5 16 17 23 25 27 30
ST	40, 93	77 | 14 / 2 | 28	.875	.721	77	88	116	32 50 52 57 59 62 72 76 82 87 88 96 109 / 16 27
WE	40, 93	86 | 4 / 6 | 24	.917	.774	96	94	118	32 52 76 109 / 5 16 17 23 27 30

Table 24

Decision Validity Coefficients Using Both Bruininks and Cornish Test (Administration 2) Scores to Predict APE Assignment

Inference Type	Cutting Scores	TA | FNA / FA | TNA	C	ϕ	ψ_a	ψ_b	ψ_c	S's wrongly assigned to APE S's not assigned to APE
ST	40, 91	82 | 8 / 3 | 27	.908	.773	90	95	122	32 51 52 62 72 76 109 115 16 23 27
WE	40, 91	88 | 2 / 9 | 21	.908	.746	96	89	110	76 109 5 12 14 16 17 23 25 27 30
ST	40, 92	82 | 8 / 3 | 27	.908	.773	90	95	122	32 51 52 62 72 76 109 115 16 23 27
WE	40, 92	88 | 2 / 9 | 21	.908	.746	96	89	110	76 109 5 12 14 16 17 23 25 27 30
ST	40, 93	79 | 11 / 3 | 27	.883	.724	81	89	116	32 51 52 59 62 72 76 82 87 109 115 16 23 27
WE	40, 93	87 | 3 / 9 | 21	.900	.722	93	87	108	32 76 109 5 12 14 16 17 23 25 27 30

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This study essentially sought to do two things: first, to determine whether the test commonly being used for determining whether a child is in need of Adapted Physical Education, the Bruininks-Oseretsky Test of Motor Proficiency - Short Form, is indeed valid for this "purpose for which it is being used" (as required by Federal mandate); second, to determine whether a newly-proposed and rather simple test, the Cornish Test of Motor Planning, might be useful for the same purpose, either solely or in conjunction with the Bruininks Test.

Our findings indicate that the Bruininks-Oseretsky Short Form Test can indeed be judged valid in terms of its effectiveness in recommending children in need of Adapted Physical Education. The use of an appropriate cutting score seemingly identifies needful students with an accuracy of the order of about 90%. Furthermore, the test seems to have about the same degree of successfulness with children who are learning disabled. The long-term reliability of the test, over a period of about 17 months, also proved to be very good.

The Cornish Test of Motor Planning also demonstrated a good ability to discriminate children in need of Adapted Physical Education. This was somewhat surprising because experience with administration of the test revealed that a number of the test procedures (including scoring methods) were ill-defined. These problems seemed to cause test-retest reliability, from a decision consistency standpoint, to be a little below a satisfactory level. Nevertheless, there are many indications from our data that the Cornish test could, with improvement, be a useful tool in assisting identification of children in need of APE assignment.

No evidence was found to indicate that the use of both the Bruininks-Oseretsky and Cornish tests together would improve the accuracy of assignment decisions. This fact adds force to the observations of Ysseldyke and his colleagues that persons making decisions about assignment to special and remedial education services do not seem to be able to use and combine in any rational way the assessment data that they get brought before them (Ysseldyke, Algozzine, Richey, & Graden, 1982). By examining IEP profiles, we found that the factor most able to explain the 10% (approximate) misclassification made by a single administration of the Bruininks Test was anecdotal data unrelated to test performance--often the identification of the student as a "behavior problem". It does seem that gathering a great deal of

test data in order to make assignment decisions is unwarranted and fruitless insofar as it is likely to have any propitious effect on how accurately the decisions are made.

Recommendations

The following recommendations are made on the basis of our study:

1. The Bruininks-Oseretsky Short Form Test should continue to be used for determining whether children are in need of assignment to Adapted Physical Education. The technical characteristics of the test for this purpose of use appear to be very good.

2. A cutting score of 40 (Standard Score) would seem to be most accurate score to use on the Bruininks-Oseretsky Test, though scores in the 35 to 40 range are all probably similar in their effectiveness.

3. The Cornish Test of Motor Planning would be a possible alternative to use of the Bruininks-Oseretsky Test. However, we found that there are neither cost advantages or administration time advantages in use of this Test. This, in addition to the fact that administrative procedures need to be clarified and made more precise before any use is made of it.

4. There seems no advantage in using both of the tests studied because their joint use will not improve their capability of making accurate assignment decisions.

5. There seems to be cause to doubt the wisdom of spending a a large amount of time collecting different types of assessment data for the purpose of deciding whether children should be assigned to APE. Simple decision procedures based on a single test minimize test administration time and test interpretation time, but may be sufficiently effective that the extra costs of more elaborate and extensive procedures are not worthwhile. This should cause us to question the wisdom of interpreting the present legal mandate ("No single procedure is to be the sole criterion on which special education placement is determined" -- Federal Register, August 23, 1977) in the sense that multiple, formal standardized tests are required.

BIBLIOGRAPHY

Berk, R. A. (1976). Determination of optimal cutting scores in criterion-referenced measurement. Journal of Experimental Education, 45, 4-9.

Bruininks, R. H. (1978). Bruininks-Oseretsky test of motor proficiency: Examiner's manual. Circle Pines, MN: American Guidance Service.

Bruininks, R. H., Sullivan, L., & Short, N. J. (1974, April). Visual-motor abilities of learning disabled and nondisabled children. Paper presented at the 52nd Annual International Convention of the Council for Exceptional Children, New York.

Bruininks, V. L., & Bruininks, R. H. (1977). Motor proficiency of learning disabled and nondisabled students. Perceptual and Motor Skills, 44, 1131-1137.

Cornish, S. V. (1980). Development of a test of motor planning ability. Journal of the American Physical Therapy Association, 60, 1129-1132.

Enell, N. C., & Barrick, S. W. (1983). An examination of the relative efficiency and usefulness of computer-assisted individualized education programs (Report No. 34-3651-67447-01-82). Sacramento: California State Department of Education, Office of Special Education.

Hambleton, R. K. Swaminathan, H., Algina, J., & Coulson, D. B. (1978). Criterion-referenced testing and measurement: a review of technical issues and developments. Review of Educational Research, 48, 1-47.

Hambleton, R. K. (1980). Test score validity and standard-setting methods. In R. A. Berk (Ed.), Criterion-referenced measurement: the state of the art (pp. 80-123). Baltimore: The John Hopkins University Press.

Hinkle, P. D. (1981). California Master Plan for Special Education: a composite of laws. Sacramento: Office of Special Education, California State Department of Education.

Lewko, J. N. (1976). Current practices in evaluating motor behavior of disabled children. American Journal of Occupational Therapy, 30(7), 413-419.

Linn, R. L. (1979). Issues of validity in measurement for competency- based programs. In M. A. Bunda & J. R. Sanders (Eds.), Practices and problems in competency-based measurement (pp. 108-123). Washington,D. C. : National Council on Measurement in Education.

Mirkin, P. K. (1980). Conclusions. In J. Ysseldyke & M. Thurlow (Eds.), The special education assessment and decision-making process: Seven case studies. (Research Report). Minneapolis: University of Minnesota Institute for Research on Learning Disabilities.

Patterson, G. H. (1983). Investigation of two forms of the Bruininks-Oseretsky test for elementary age learning disabled students. Unpublished masters thesis, San Diego State University, San Diego.

Poland, S. F. , Ysseldyke, J. E. , Thurlow, M. L., & Mirkin, P. K. (1979). Current assessment and decision-making practices in school settings as reported by directors of special education (Research report No. 14). Minneapolis: University of Minnesota Institute for Research on Learning Disabilities.

Salvia, J., & Ysseldyke, J. E. (1981). Assessment in special and remedial education (2cd ed.). Boston: Houghton-Mifflin.

SPSS Inc. (1983). SPSSX users guide. New York: McGraw-Hill.

Staples, H. T., & Bruininks, R. H. (1977, March). Motor ability of EMR, TMR, and nonhandicapped children. Paper presented at the First International Symposium on Adapted Physical Activity, Quebec.

Subkoviak, M. J. (1980). Decision-consistency approaches. In R. A. Berk (Ed.), Criterion-referenced measurement: the state of the art (pp. 129-185). Baltimore: The John Hopkins University Press.

Swaminathan, H., Hambleton, R. K., & Algina, J. (1974). Reliability of criterion-referenced tests: A decision-theoretic formulation. Journal of Educational Measurement, 11, 263-267.

Thurlow, M. L., & Ysseldyke, J. E. (1979). Current assessment and decision-making practices in model programs for the learning disabled. Learning Disability Quarterly, 2, 15-24.

Washburn, R. A., & Safrit, M. J. (1982). Physical performance tests in job selection. A model for empirical validation. Research Quarterly for Exercise and Sport, 53(3), 267-270.

Ysseldyke, J. E., & Algozzine, B. (1982). Critical issues in special and remedial education. Boston: Houghton Mifflin.

Ysseldyke, J. E., Algozzine, B., Richey, L., & Graden, J. (1982). Declaring students eligible for learning disability services: why bother with the data? Learning Disability Quarterly, 5, 37-44.

Ysseldyke, J. E., Thurlow, M., Graden, J., Wesson, C., Algozzine, B., & Deno, S. (1983). Generalizations from five years of research on assessment and decision making: The University of Minnesota Institute. Exceptional Education Quarterly, 4(1), 75-93.

Appendix A

Letter of Approval for Human Subjects Use,
San Diego State University

COMMITTEE ON PROTECTION OF HUMAN SUBJECTS
SAN DIEGO STATE UNIVERSITY
SAN DIEGO CA 92182

(619) 265-6622

September 6, 1983

Dr. Peter M. Aufsesser
Dr. Harry A. King
Physical Education Department
San Diego State University

SUBJECT: Study #83-4-122
"A Decision-theoretic Examination of the Usefulness of two Motor Performance Tests in Identifying Children for Assignment to Adapted Physical Education"

Dear Dr. Aufsesser and Dr. King:

We are pleased to inform you that the conditions of your approval have been satisfied.

If you should need additional information about the use of human subjects, please contact our office at 265-6622.

R E Lundberg

Ralph E. Lundberg, Executive Officer
Committee on Protection of Human Subjects

REL:hsf

cc: Physical Education Dept
Ms. Jan Patterson

SC

Appendix B

Letter of Approval for Human Subjects Use,
Encinitas Union School District

NITAS UNION SCHOOL DISTRICT
189 UNION STREET
ENCINITAS, CALIFORNIA 92024
AREA CODE 619 753-1152

BOARD OF TRUSTEES
Norman L. MacIntyre, President
Anthony J. Brandenburg, Clerk
Ronald A. Countryman, Member
Mary Jo Norman, Member
Sandra Schuhs, Member

Donald E. Lindstrom, Superintendent
and Board Secretary

"Excellence Is Our Goal"

June 9, 1983

To Whom It May Concern:

This letter will affirm that at a Regular Meeting on May 12, 1983, the Board of Trustees of the Encinitas Union School District did adopt the following resolution upon unanimous affirmative vote:

> Be it resolved that the Board of Trustees of the Encinitas Union School District does hereby approve the research project to be conducted by the San Diego State University professors and our Adapted P.E. teacher.

Sincerely,

Donald E. Lindstrom
Superintendent of Schools
and Board Secretary

h

BEST COPY AVAILABLE

Appendix C

Parent Permission Form for Use of IEP Folders

PARENT PERMISSION FORM A

Date:

Dear Parent:

Your child is invited to participate in a study that will allow us to learn more about *motor performance of students in the Encinitas Union School District. As the Adapted Physical Education Specialist for the district, I will be responsible for administering the motor performance tests. In addition, Dr. Peter M. Aufsesser from San Diego State University will aid me in the collection of the motor information. We both have extensive experience in testing the motor performance of children. Due to time constraints imposed by the district's tracking system, we would appreciate your returning the permission form as soon as possible.

If you decide to have your child participate, your child will be administered the Burininks-Oseretsky Test of Motor Proficiency and the Cornish Test of Motor Planning. The tests will be given in privacy and at the classroom teacher's convenience so as not to disrupt your child's academic program. After the test information has been analyzed, the results of the study will be reported in educational journals and at educational meetings. No data on particular children will be reported. Any information that is obtained in connection with this study will remain confidential.

If you have any questions, please do not hesitate to call me, Jan Patterson, 436-7587, Monday through Friday between 4 and 5 p.m.

_____ _____

Name of Student Parent or Guardian

_____ _____

Investigator Relation to Student

_____

Date

*Motor Performance

Motor performance items measure a variety of skills which use such individual traits as strength, endurance, speed, agility, balance and coordination. These skills are routinely tested in the schools to determine a child's progress.

Appendix D

Items and Instructions for the Cornish Test of Motor Planning

APPENDIX D

1. IMITATIVE CRAWLING

Materials Required -- none

Directions -- "You do as I do. If I move this hand (R), you move this hand (points to child's right hand), and if I move this hand (L), you move this hand." (Points to child's left hand). "If I move this leg (L) which one do you move?" (Correct the child if he responds incorrectly.) "Now watch carefully and do not move unless I do."

Activity -- Examiner moves in the following sequences in a 4 point position and child follows:

a) Left arm, Right leg, Right arm, Left leg
b) Left arm, Right arm, Left leg, Right leg
c) Left arm, Left leg, Right arm, Right leg
d) Left arm and Right leg simultaneously, Right arm and Left leg simultaneously

Scoring -- The score is total number of correct moves. It is obtained by substracting the number of errors from 16.

An error is:
- moving the wrong limb
- reversals (moving right arm instead of left, etc.)
- beginning to move the wrong limb and then correcting the movement
- moving before the examiner

It is not considered an error when the child is slow to respond but responds correctly.

2. ROPE TEST A

Materials Required -- 24 foot rope, stopwatch.

Beginning Position -- Child stands at one end of a 24 foot rope which is placed on the floor in the following pattern:

Directions -- "Walk along the rope like this as quickly as you can all the way to the end without making a mistake." (Examiner demonstrates as described in activity.) "It is not necessary to demonstrate the whole rope -- 6 steps is all that are required."

Activity -- Examiner demonstrates walking along rope by placing right foot on left side of rope and left foot on right side of rope. The foot should cross over without touching the rope.

Two demonstrations and trials are allowed if necessary.

Scoring -- Performance time in seconds_____.

An error is: putting the foot down on the wrong side of the rope
stepping on the rope
not completing the whole rope

3. ROPE TEST B

Materials Required -- 24 foot rope, stopwatch.

Beginning Position -- Child stands at one end of a 24 foot rope which is placed on the floor in the following pattern:

Directions -- "Follow along the rope without stepping off it and jump over each spot where the rope crosses."

Activity -- The child walks along the rope tandem style and jumps when he comes to an intersection of the rope.

Two demonstrations and trials are allowed if necessary.

Scoring -- Performance time in seconds_____.

An error is: stepping off the rope
not completing the whole rope.

Do not ccunt recovery after a jump as an error.

4. JUMPING JACK

Materials Required -- Stopwatch.

Beginning Position -- Standing, feet together, arms down at the sides.

Directions -- "Let me see you do a jumping jack. Now do as many as you can until I tell you to stop."
"Ready, Go"; "Stop"

If the child is unable to perform a jumping jack give him assistance as follows:

a) One demonstration "Like this - now you try it."

b) Two demonstrations and two trials.

Activity -- Child performs as many jumping jacks as he can within a 10 second period.

Scoring -- Number of jumping jacks successfully completed

(To be successful both arms and legs must move in the proper pattern and the jump must be included.)

5. THROW-CLAP-CATCH

Materials Required -- tennis ball, stopwatch, counter (optional).

Beginning Position -- Standing, holding a tennis ball.

Directions -- "Throw the ball in the air, clap your hands, and then catch it." The child is allowed two trials if necessary. A demonstration may be given after the first trial if the child does not seem to understand the task but this should be noted. Once the child can accomplish the task go on. "When I say 'Go' I want you to throw the ball, clap your hands and catch the ball as many times as you can until I tell you to stop. Ready, Go. Stop."

Activity -- The child is to throw the ball up, clap his hands, and catch the ball as many times as he can within 30 seconds. Stop timing if the child drops the ball and continue when he has picked it up.

Scoring -- Number of correct sequences in 30 seconds_____.

A sequence is considered incorrect if:
the child does not clap or
the child drops the ball or
the child claps more than once

6. GRASP STRENGTH

Materials Required -- Dynamometer.

Beginning Position -- Sitting with arm extended down at his side, hold dynamometer set at one notch.

Directions -- This tells me how strong you are in your hands; squeeze it really, really hard."

Activity -- Child squeezes the dynamometer with his dominant hand for two trials.

Scoring -- Strength in pounds:

Dominant - Trial 1_____
Trial 2_____

Revised Score Sheet

Name_____ Test Date_____

Date of Birth_____

1. Imitative Crawling_____/16
2. Rope A_____seconds
3. Rope B_____seconds
4. Jumping Jacks_____
5. Throw-Clap-Catch_____
6. Dominant Strength_____pounds

Overall Score is determined by the following formula:

Imitative Crawling + Jumping Jacks + (60-Rope A) + (60-Rope B) + (3x Throw-Clap-Catch) + (4x Dominant Strength) = S

$\frac{S}{2} - 23$ = Developmental Age in months (as estimated)

$\frac{\text{Computed Age}}{\text{Chronological Age}} \times 100\% =$ % of Developmental Age (Composite Score)

EXAMPLE

8 year old child (96 months)

Imitative Crawling	10
Jumping Jacks	7
Rope A = 25 (60 - Rope A)	35
Rope B = 22 (60 - Rope B)	38
Throw-Clap-Catch = 12 (3x TCC)	36
Dominant Strength = 15 (4x Dominant Strength)	60
TOTAL (S)	186

$\frac{186}{2} - 23 = 70$ (Estimated Developmental Age)

$\frac{70}{96} \times 100\% = 73\%$ (Estimated % Developmental Age)

This child performs at 73% of what is expected for an 8 year old child.

Appendix E

Outline of Statistical Methods for Decision Validation

APPENDIX E

Concepts of decision validity and reliability have grown up in response to the needs of assessing the successfulness of criterion-referenced tests. The new popularity of these last kinds of test has forced attention to validity and reliability issues which lie outside the traditional, correlational framework. Descriptions of the developing methods can be found in a variety of sources which discuss and explicate methodologies used in clinical and personnel decision-making (Cronbach & Gleser, 1965, Ch. 3; Klein & Cleary, 1967; Meehl & Rosen, 1955; Wiggins, 1973, Ch. 6).

The fundamental problem that faces the person utilizing a criterion-referenced test is to make a judgment about whether an observed performance on a test merits one inference or another about the testee making the observed performance. The desired inference may be about whether the testee can be judged to have reached some level of competency in a domain of skills that the test samples; or, equivalently, it may be about whether the testee should be judged as belonging to one or other of some pre-existing actual or conceptual groups. To take a simple illustrative case, suppose a test X is given to 100 persons to determine whether they are assigned to one of two groups, A or B. It is assumed that membership in one or other of the groups is not an arbitrary matter, but has a "truth" that the test administrator is trying to fathom. For example, Group A might imply "suitable for employment as a police officer", and Group B "Not suitable for employment as a police officer". Test X is trying to fathom the truth of which group an applicant be assigned to, and hopefully will come as close to the real "truth" as possible. In the criterion-referenced testing terminology, the test X is referred to as a "decision test", and the truth of the assignment decision which is to be made is referred to as the "criterion test". The criterion test measures status on the "classification variable".

Obviously, to make a judgment from the decision test one needs to establish a score (a "cutting score") to guide ones judgment -- for example, a subject's scoring ABOVE the cutting score leads one to assign him/her to group A, and scoring below the cutting score leads one to assign him/her to group B. Two questions will obviously arise: (1) how accurate (i.e. valid) is the test in making a correct assignment to the groups? and, (2) how consistent would the test be, if administered twice, in assigning subjects to the groups? These two questions illustrate the central concerns of decision validity and decision reliability.

In order to investigate the validity of a decision test, the results of some criterion test must known, or able to be gathered: for example, the results may be knowable by

administration of a long and complicated set of testing procedures that are impractical to give on any large-scale basis. Then, by gathering data on some more practical test (the decision test), we are able to investigate how the results of the decision test might be most wisely used in order to mirror the criterion "truth".

The results of a decision-model validity (or reliability) investigation become reduced, in the final stage, to a so-called classification table which is presented as follows:

		DECISION TEST: ACCEPT	DECISION TEST: DO NOT ACCEPT
CRITERION TEST	TRULY ACCEPTABLE	a (TA)	c (FNA)
	TRULY NOT ACCEPTABLE	d (FA)	b (TNA)

The frequencies of subjects in each of the 4 decision categories shown are a, b, c, and d, as indicated. Subjects in each of the four categories are characterized by the acronyms:

TA -- True Acceptance; a subject correctly assigned as acceptable. (In the criterion-referenced testing framework, this is usually denoted TM, or True Master.)

FNA -- False Non-Acceptance; a subject was falsely judged to be not acceptable. (In the criterion-referenced test framework, this is usually denoted FN, or False Negative.)

FA -- False Acceptance; a subject was falsely thought to be acceptable . (In the criterion-referenced test framework, this is usually denoted FP, or False Positive.)

TNA -- True Non-Acceptance; a subject was correctly judged to be not acceptable. (In the criterion-referenced test framework, this is usually denoted TNM, or True Non-Master.)

In the present study, we make the arbitrary assumption to equate "acceptability" to the circumstance that a student DOES NOT need APE, and "non-acceptability" to the circumstance that a student DOES need APE. We have implicitly taken "acceptable", therefore, to have its usual connotation of indicating that a

score ABOVE a given pre-specified level has been obtained on a test. This assumption is irrelevant to the substance of our study, but does clarify the manner in which we will presenting tabular information in the text. Translating the general classification table as shown above to the particular purposes of our study, then, we may represent the actual form of the classification table, as we shall use it, to that shown in Table 25.

A number of statistical indices have been proposed to measure the extent to which the decision test is accurate. (These are clearly related to maximizing a and b, and minimizing c and d.). We chose to utilize 3 of these:

1. Classification success coefficient, C. This is the probability of a correct classification (p(TA) + p(TNA)).

2. Phi Validity coefficient, ϕ. This is a measure of the extent to which a predictor classification accurately estimates the criterion classification. It is calculated as:

$$= \frac{TA - BR \times SR}{SQR[\, BR \times (1-BR) \times SR \times (1-SR) \,]}$$

where

SQR[ ] = square root function
TA = p(TA)
BR = p(TA) + p(FNA)
SR = p(TA) + p(FA)

(p() signifies a probability)

3. Utility analysis coefficients, ψ_a , ψ_b, and ψ_c. A utility analysis does not, as the previous two coefficients do, presume each of the correct or incorrect classification decisions to be equally important. The investigator, instead, assigns weight that represent the importance of each decision outcome. For the present study, three cases were considered:

ψ_a -- wrongly assigning a child to APE (i.e. assigning him/her when he/she does not in fact need it) is TWICE as undesirable as not assigning him/her when he/she does in fact need it. Mathematically, FNA/FA = -2/-1

ψ_b -- assigning the child to not have NOT have APE when in actuality he/she does need it is TWICE as undesirable as assigning him/her to APE when in fact he/she does not need it. Mathematically, FA/FNA = -2/-1

Table 25

The Classification Table as Used in this Study

		DECISION TEST: ACCEPT	DECISION TEST: DO NOT ACCEPT
CRITERION TEST: TRULY ACCEPTABLE (APE NOT NEEDED)		(TA) We say he/she does not need APE and he/she truly doesn't	(FNA) We say he/she does need APE but he/she truly doesnt
CRITERION TEST: TRULY NOT ACCEPTABLE (APE IS NEEDED)		(FA) We say he/she doesn't need APE and he/she truly does	(TNA) We say he/she does need APE and he/she truly does

ψ_c -- in this case 2 conditions are postulated -- the same condition as cited for ψ_b above, and ALSO that finding True Non-Acceptances is TWICE as important as assigning True Acceptances. Mathematically, this is expressed as:

$$FA/FNA = -2/-1$$
$$\text{and} \quad TNA/TA = 2/1$$

Joint Use of Decision Variables

In the methods we have described above, there has always been assumed to be ONE criterion variable and ONE decision variable. Suppose, however, that we have TWO decision variables available. Can we utilize the two together to improve decision practices? (Of course, the truth of this is somewhat assumed by the common practice, in the IEP decision procedures, of utilizing batteries of tests.) In one sense, it would seem obvious that having more information available is beneficial. Yet the work of Ysseldyke and his colleagues, referred to throughout this study, casts doubt on the supposition. The problem, essentially, is that unless we have sound and practical means of combining multiple and diverse information, it is likely to be no use to us.

In the one-decision-variable case, it has been explained that a cutting score is established that divides students into one of two categories on the classification variable. Students above the cutting point are assigned to one category, students below the cutting score are assigned to the other. In the two-decision-variable case, we have the more complicated problem of determining how we shall interpret the four possible outcomes (pass-pass, pass-fail, fail-pass, fail-fail) in terms of classification variable assignment.

Two different tactics are possible in combining the results;

1. A student IS NOT assigned to APE if his/her performance passes (i.e. is above the chosen cutting score) on BOTH decision tests, but IS assigned to APE if he/she scores above the cutting score on only one or neither test. We term this the case of "strong inference" because we have stronger confidence that any student likely to be needing APE will getting assigned to it.

2. A student is NOT assigned to APE unless BOTH of the decision tests are failed. This is termed the case of "weak inference" because we have weaker confidence that we have detected all students possibly in need of APE.

(We note that the views of strong and weak taken here are from the point of view that stresses the importance of trying to detect as many as possible of the students who need APE

assignment. The contrary view, that would stress the importance of not falsely assigning children to APE who do not need it, would lead to a reverse of these assumptions of "strong" and "weak".)

The various judgment circumstances (and the subsequent truth of the decision outcomes) are listed in Table 26.

It can be seen that each of the five coefficients considered (C, ϕ, ψ_a, ψ_b, and ψ_c) gives different information by which to judge the successfulness of the decision test. In judging which cutting score most successfully leads to correct decision, we examine each coefficient for its maximal value (across cutting scores). It is often found -- and generally was so in this investigation -- that the majority of the five coefficients, and sometimes all, become maximized at a particular cutting score.

References

Cronbach, L. J., & Gleser, G. C. (1955). Psychological tests and personnel decisions (2nd. ed.). Urbana, IL: University of Illinois Press.

Klein, D. F., & Cleary, T. A. (1967). Platonic true scores and error in psychiatric rating scales. Psychological Bulletin, 68, 77-80.

Meehl, P. E., & Rosen, A. (1955). Antecedent probability and the efficiency of psychometric signs, patterns, and cutting scores. Psychological Bulletin, 52, 194-216.

Wiggins, J. S. (1973). Personality and prediction: Principles of personality assessment. Reading, MA: Addison-Wesley.

Table 26

Strong and Weak Inference Strategies in Decision Classification Using Two Decision Tests

True Criterion Classification	Result of Decision Test 1	Result of Decision Test 2	Strong Inference Decision	Weak Inference Decision
No APE	No APE	No APE	No APE (TA)	No APE (TA)
No APE	Need APE	Need APE	Need APE (FNA)	Need APE (FNA)
No APE	No APE	Need APE	Need APE (FNA)	No APE (TA)
No APE	Need APE	No APE	Need APE (FNA)	No APE (TA)
Need APE	No APE	No APE	No APE (FA)	No APE (FA)
Need APE	Need APE	Need APE	Need APE (TNA)	Need APE (TNA)
Need APE	Need APE	No APE	Need APE (TNA)	No APE (FA)
Need APE	No APE	Need APE	Need APE (TNA)	No APE

Letters in parentheses show decision truth as explained in Table 25 (Appendix E). TA=True Acceptance FNA=False Non-Acceptance FA=False Acceptance TNA=True Non-Acceptance

Appendix F

Raw Data on Motor Performance
Collected in October/November 1983

APPENDIX F

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001 1  091  2   24 08  01 01 00 00 00 03 01 01 00 00 00 00 00 01      1
 046  15 01 00 00 11 48 02 00 080   012  13 03 00 00 00 00 02 03 068 2
002 1  092  1   24 06  00 00 00 00 00 00 00 02 00 00 00 00 01 03      1
 000  16 06 00 00 00 00 00 00 040   001  16 08 00 00 00 00 00 00 040 2
003 1  133  1   24 53  09 04 04 00 02 08 03 02 09 04 01 00 04 03      1
 082  08 08 04 52 12 46 13 26 120   071  07 09 00 00 18 50 10 45 120 2
004 1  126  2   24 34  07 03 00 00 01 06 03 02 05 02 00 00 02 03      1
 050  05 12 08 10 06 44 00 06 100   056  03 13 05 15 07 45 02 12 100 2
005 1  079  1   43 26  00 06 00 00 02 03 02 01 04 02 01 00 02 03      1
 049  16 00 00 00 11 38 00 06 080   060  16 00 10 20 13 35 00 06 080 2
006 1  111  1   24 17  02 01 00 00 00 04 01 02 00 02 02 00 02 01      1
 024  16 00 00 00 00 00 00 00 100   024  16 00 00 00 00 00 00 00 100 2
007 1  121  1   24 32  06 02 01 00 01 06 02 00 05 02 01 01 02 03      1
 080  08 12 03 36 12 40 00 40 104   087  10 09 01 46 11 44 00 48 108 2
008 1  146  1   24 18  00 04 00 00 00 02 03 02 00 00 00 00 02 04      1
 016  02 00 00 00 00 00 06 84 018   084  18 04 00 00 00 00 03 12 080 2
009 1  077  1   32 18  03 01 01 00 00 03 01 00 01 01 01 01 01 02      1
 047  12 06 03 42 15 22 04 00 044   066  09 07 04 40 14 24 15 00 072 2
010 1  084  2   24 09  00 01 00 00 01 01 02 02 00 00 00 00 01 01      1
 000  16 01 00 00 00 00 00 00 004   000  16 04 00 00 00 00 00 00 020 2
011 1  133  1   24 12  00 02 00 00 00 01 01 00 02 02 00 00 02 02      1
 058  16 02 12 39 18 18 00 00 140   055  16 04 14 17 00 09 01 00 160 2
012 1  146  1   24 43  04 06 01 00 01 07 02 02 05 04 01 02 03 05      1
 082  04 12 03 30 10 35 09 42 156   105  08 09 03 47 20 39 17 60 180 2
013 1  096  2   24 11  00 00 00 00 00 01 02 01 00 00 00 00 03 03      1
 000  16 03 00 00 00 00 00 00 040   000  16 08 00 00 00 00 02 00 044 2
014 1  108  1   38 45  04 02 00 00 01 06 03 02 10 04 01 01 03 04      1
 091  17 05 01 45 10 39 00 30 124   102  05 16 05 45 11 45 00 48 154 2
015 1  065  1   39 11  01 01 00 00 00 03 00 01 00 00 01 00 02 02      1
 013  11 05 00 00 00 00 00 00 060   017  09 07 00 00 00 00 02 00 060 2
016 1  103  1   63 60  07 06 04 01 04 09 03 02 12 04 01 00 03 04      1
 093  08 11 04 35 13 42 00 30 120   100  10 10 00 33 08 43 06 42 120 2
017 1  097  1   50 48  07 06 04 00 03 06 01 01 09 04 00 00 03 04      1
 081  11 05 03 39 06 40 00 33 084   083  10 06 02 40 08 28 00 39 092 2
018 1  069  1   30 13  01 04 02 00 00 02 01 01 00 00 00 00 01 01      1
 013  16 00 00 00 00 00 00 00 064   010  16 00 00 00 00 00 00 00 060 2
019 1  117  1   24 30  03 04 00 00 01 03 03 02 02 04 02 01 02 03      1
 058  12 04 12 40 16 25 00 12 100   067  11 05 04 49 15 28 01 15 104 2
020 1  148  1   24 48  07 06 [illegible] 01 02 09 03 03 03 04 00 00 02 04      1
 085  10 11 03 50 11 50 12 60 [illegible]16   090  60 12 00 49 13 52 12 66 120 2
021 1  156  2   24 29  00 02 00 00 00 07 03 02 02 04 01 00 03 05      1
 077  00 00 00 54 00 00 00 00 232   080  00 05 00 50 00 00 00 00 240 2
022 1  078  1   24 10  00 02 00 00 00 01 02 01 00 00 00 00 01 03      1
 011  16 03 00 00 00 00 00 00 060   020  16 05 00 00 00 00 00 00 072 2
023 1  113  1   50 54  07 06 04 00 04 09 02 02 07 03 01 01 05 03      1
 083  07 09 00 00 18 50 08 42 124   099  09 07 13 54 18 46 07 36 120 2
024 1  147  1   24 27  04 02 01 00 01 07 02 03 04 00 01 00 01 01      1
 039  15 01 00 00 00 00 00 00 160   039  00 00 00 00 00 00 00 00 160 2
025 1  096  1   31 30  03 03 00 00 01 03 03 03 01 04 01 02 03 03      1
 092  08 08 08 43 07 40 00 12 120   102  03 13 14 45 10 38 00 18 128 2
026 1  141  1   24 45  07 02 01 00 02 09 03 03 11 02 00 00 02 03      1
 073  15 06 04 36 13 30 06 45 128   069  10 10 04 23 19 15 11 45 136 2
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027 1  135  1   47 61  08 06 04 00 03 11 03 02 12 03 01 00 04 04      1
 100  04 12 00 37 34 35 06 45 180   113  05 15 00 32 02 14 08 63 220 2
028 1  066  1   28 11  00 01 01 00 01 01 03 02 00 00 00 00 00 02      1
 000  00 00 00 00 00 00 02 00 044   029  16 00 00 00 00 00 04 08 080 2
029 1  092  1   24 11  03 01 00 00 00 01 01 01 00 00 00 00 02 02      1
 011  16 10 00 00 00 00 00 00 056   014  16 12 00 00 00 00 00 00 060 2
030 1  149  1   24 37  05 03 01 00 02 05 02 02 05 02 02 02 02 01      1
 099  02 14 02 45 09 37 02 63 180   094  02 14 07 38 08 36 02 57 180 2
031 2  117  1   62 65  11 06 04 01 03 10 03 03 08 04 01 02 04 07      1
 108  01 16 01 51 02 38 00 54 140   111  09 09 04 52 09 29 12 69 100 2
032 2  130  2   35 52  07 06 04 00 03 11 03 03 01 04 01 01 04 04      1
 082  02 16 00 40 01 30 10 63 100   092  00 16 00 44 02 32 12 69 100 2
033 2  108  1   62 62  09 06 04 00 04 11 03 01 12 02 00 00 04 06      1
 116  08 08 04 51 13 49 06 42 140   125  02 14 03 51 15 50 08 48 144 2
034 2  113  1   60 55  09 06 03 00 03 07 03 03 08 01 01 00 02 09      1
 131  02 16 00 53 03 48 19 60 120   141  06 10 03 51 10 39 20 72 144 2
035 2  129  1   75 76  09 06 04 01 05 12 03 03 12 04 01 02 06 08      1
 147  06 10 04 54 14 50 15 96 200   146  07 09 10 55 16 46 14 99 200 2
036 2  116  1   63 66  10 06 04 00 03 10 03 03 10 02 01 02 06 06      1
 116  04 14 06 50 06 46 17 60 128   113  00 16 00 45 07 45 16 66 120 2
037 2  142  1   65 73  09 06 04 01 05 09 03 03 13 04 02 02 05 07      1
 117  04 12 07 53 08 47 12 75 180   116  05 13 01 54 05 47 14 69 180 2
038 2  128  1   54 69  09 06 04 01 03 12 03 03 11 04 00 00 03 04      1
 152  13 07 00 40 10 41 13 63 272   157  10 06 00 45 13 38 13 66 280 2
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 096  10 06 05 46 08 39 12 48 180   093  12 04 04 45 10 37 12 48 180 2
040 2  116  1   47 55  11 04 02 00 02 10 03 03 06 03 01 00 04 06      1
 110  04 14 10 51 06 48 00 45 144   115  03 16 00 45 05 47 00 45 160 2
041 2  133  1   45 65  09 06 04 01 02 11 03 03 11 02 00 01 05 07      1
 098  07 09 02 46 10 47 07 39 160   100  05 11 00 47 07 40 08 45 160 2
042 2  131  2   42 56  09 03 00 00 03 10 03 03 11 00 02 01 05 06      1
 145  01 16 00 52 10 36 14 69 240   146  00 16 00 51 08 37 14 72 240 2
043 2  140  1   75 80  13 06 04 01 05 13 03 03 16 03 00 01 06 06      1
 114  00 16 00 48 13 44 16 60 180   114  00 16 00 48 13 50 16 54 180 2
044 2  110  1   60 61  09 06 04 01 04 08 03 02 11 04 00 01 04 04      1
 115  02 16 04 51 02 08 10 75 140   121  00 16 00 51 03 25 10 72 140 2
045 2  120  1   45 56  07 06 04 00 02 09 03 03 10 02 02 02 03 03      1
 119  05 14 00 51 00 25 10 60 172   123  04 12 00 51 10 23 10 66 180 2
046 2  126  1   66 70  09 06 04 01 03 11 03 03 14 02 02 01 06 05      1
 123  04 12 05 52 16 39 16 72 164   123  04 13 03 52 10 38 17 78 160 2
047 2  136  2   60 68  11 05 03 01 03 11 03 03 11 04 00 01 08 04      1
 129  00 16 00 53 00 41 17 90 180   142  02 14 00 50 08 45 18105 200 2
048 2  143  2   55 67  09 06 04 01 03 09 03 03 11 04 01 01 06 06      1
 104  00 16 00 52 00 40 15 81 140   099  00 16 11 52 10 46 12 81 124 2
049 2  116  1   56 61  11 06 01 00 02 09 03 02 11 04 02 01 03 06      1
 121  00 16 02 52 13 41 15 63 140   138  00 16 03 54 10 46 18 84 148 2
050 2  119  2   43 52  05 06 04 01 03 06 03 03 05 04 01 01 05 05      1
 084  00 16 00 43 03 05 12 69 100   109  03 14 00 53 04 28 15 93 104 2
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 098  02 14 03 57 11 41 16 63 140   067  02 16 04 52 06 19 13 69 048 2
052 2  145  1   30 54  08 06 02 00 02 07 03 03 09 04 00 01 05 04      1
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053 2  132  1   47 61  07 06 04 01 03 10 03 02 09 04 01 01 05 05      1
 098  07 09 02 51 06 39 00 66 140   099  02 14 00 56 09 34 00 69 140 2
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 112  02 14 06 52 16 18 06 45 100   106  03 14 08 47 18 28 04 51 080 2
055 2  132  2   56 66  10 06 04 01 03 11 03 05 15 04 01 00 04 08      1
 120  01 16 02 50 25 38 17 78 164   118  00 16 00 50 15 34 17 81 160 2
056 2  114  1   52 58  09 06 04 01 03 09 03 03 07 04 01 00 03 05      1
 104  04 16 00 48 01 42 13 63 100   108  09 11 04 54 16 40 11 72 104 2
057 2  137  1   49 62  08 06 04 01 03 10 03 02 09 04 00 02 04 06      1
 081  00 16 02 52 02 41 03 75 080   117  01 15 01 51 03 37 13 00 160 2
058 2  095  1   49 44  09 03 04 00 01 09 02 02 06 02 01 01 02 01      1
 106  05 11 03 45 09 29 00 42 120   116  09 10 05 53 15 36 06 42 120 2
059 2  119  2   41 51  06 06 04 00 03 07 02 01 09 04 00 01 02 06      1
 076  02 14 05 30 00 45 12 27 100   092  00 16 02 52 08 33 11 54 100 2
060 2  107  1   75 71  11 06 04 01 02 11 03 03 12 04 00 02 05 07      1
 113  00 16 00 51 02 33 13 63 140   116  01 16 00 50 08 29 12 72 144 2
061 3  138  2   71 76  11 06 04 01 03 11 03 03 12 04 02 02 06 08      1
 115  02 14 00 48 00 39 15 87 160   116  01 15 01 52 03 40 15 84 160 2
062 3  112  1   38 45  07 03 02 00 01 06 03 03 04 04 01 01 05 05      1
 115  02 14 02 52 13 45 16 57 120   110  00 16 03 53 04 46 00 69 108 2
063 3  118  2   57 62  09 06 04 01 03 07 03 01 07 03 01 01 08 08      1
 104  00 16 04 44 01 39 16 75 100   117  00 16 00 53 01 48 17 87 100 2
064 3  135  1   53 64  09 06 04 01 03 10 03 03 09 03 00 01 06 06      1
 115  00 16 05 50 03 52 16102 120   118  01 15 02 53 02 39 15120 124 2
065 3  126  1   66 70  12 06 04 00 03 09 03 03 10 04 01 02 07 06      1
 133  03 13 01 50 00 37 15 75 192   137  01 15 00 54 02 41 16 93 172 2
066 3  085  2   70 56  09 06 04 01 02 09 03 03 04 04 02 00 04 05      1
 143  00 16 01 52 21 48 00 54 120   149  03 13 02 53 14 50 09 54 120 2
067 3  131  1   72 73  10 06 04 01 04 11 03 03 13 04 01 02 06 05      1
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068 3  090  1   71 61  07 06 04 01 04 07 03 02 11 04 01 01 04 06      1
 139  06 10 01 44 01 34 00 48 160   149  06 12 02 50 08 41 08 63 140 2
069 3  130  1   52 62  08 06 04 01 04 10 03 02 09 04 01 01 05 04      1
 139  00 16 04 51 03 52 14 75 200   129  03 13 00 54 08 45 14 72 184 2
070 3  093  1   69 60  13 06 04 01 03 08 02 01 11 02 01 01 03 04      1
 099  00 16 03 44 03 39 00 12 120   118  07 12 02 50 14 48 00 36 120 2
071 3  131  2   54 63  07 06 04 01 04 09 03 02 09 03 01 01 06 07      1
 095  00 16 01 45 00 23 12 78 120   113  00 16 02 54 04 41 14 78 140 2
072 3  064  1   49 19  03 02 00 00 00 02 03 01 02 02 01 00 01 02      1
 061  16 00 12 46 15 27 12 00 040   070  04 13 00 33 02 31 13 06 040 2
073 3  137  2   67 74  11 06 04 01 04 10 03 02 11 04 01 02 08 07      1
 113  00 16 00 88 00 53 16102 120   111  00 16 00 53 02 48 20 84 128 2
074 3  129  1   50 61  09 06 04 00 03 08 03 03 07 04 02 02 05 05      1
 094  00 16 00 34 07 36 12 63 140   110  06 10 00 52 11 46 14 69 140 2
075 3  089  1   66 53  07 06 04 01 02 05 03 02 10 04 01 01 04 03      1
 124  07 09 04 27 03 40 05 45 140   131  06 10 00 24 05 42 07 51 144 2
076 3  136  2   24 42  07 04 04 01 01 08 03 02 03 03 00 00 04 02      1
 047  03 13 01 34 00 00 05 42 080   074  05 11 04 47 13 30 13 72 076 2
077 3  149  1   70 78  13 06 04 01 05 12 03 03 10 04 02 02 06 07      1
 128  00 16 00 47 02 39 18108 200   129  00 16 01 46 00 37 18118 200 2
078 3  141  1   75 85  12 06 04 00 04 13 03 03 16 04 02 02 07 09      1
 138  00 16 00 52 07 44 17 72 252   142  01 15 02 20 01 41 15105 220 2
079 3  133  1   65 71  09 06 04 01 02 10 03 03 15 04 01 01 06 06      1
 101  00 16 03 45 02 05 13 36 200   109  02 14 02 50 01 06 14 69 184 2
080 3  121  1   66 69  13 06 04 01 03 09 03 03 09 04 02 01 06 05      1
 096  03 13 00 47 00 32 12 75 100   100  02 14 00 47 03 30 14 81 104 2
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081 3  143  1   75 79  13 06 04 01 03 13 03 03 15 03 01 01 06 07      1
 103  00 16 01 53 02 44 11 51 164   103  03 13 00 54 05 49 16 69 140 2
082 3  089  2   58 47  08 06 04 00 02 06 03 01 03 04 02 00 03 05      1
 090  02 13 06 47 20 00 13 50 080   092  09 10 00 47 04 20 13 60 060 2
083 3  120  1   63 67  12 06 04 01 03 09 03 02 10 04 02 02 05 03      1
 115  03 13 00 47 10 33 15 75 140   138  00 16 00 50 15 40 18 69 184 2
084 3  135  1   65 71  09 06 04 01 04 07 03 02 14 04 02 01 06 08      1
 130  02 14 02 50 06 36 16 60 192   133  00 16 00 50 06 38 16 84 200 2
085 3  133  1   75 77  13 06 04 00 03 11 03 03 13 04 02 02 04 08      1
 125  00 16 03 51 03 43 15 57 196   119  01 15 00 54 04 49 07 78 160 2
086 3  091  2   48 43  07 06 04 01 01 07 02 01 04 01 01 01 03 04      1
 116  06 10 00 48 08 39 12 69 080   115  04 12 00 45 07 36 13 70 080 2
087 3  062  1   61 28  08 02 00 00 02 06 02 02 00 00 02 00 01 03      1
 068  10 10 04 41 16 37 00 06 036   092  10 09 05 32 15 39 00 00 080 2
088 3  064  1   75 40  07 06 00 00 01 08 02 03 03 02 01 00 03 04      1
 041  13 06 11 41 19 19 00 00 032   094  11 05 05 39 13 35 00 03 084 2
089 3  114  1   54 60  11 04 04 00 03 12 03 03 07 04 01 01 04 03      1
 117  01 15 02 47 08 47 10 54 140   111  01 15 02 49 12 39 07 69 120 2
090 3  108  1   72 69  11 06 04 00 04 11 03 03 11 04 02 02 05 03      1
 126  04 12 00 49 00 36 13 36 172   137  02 14 02 50 05 41 12 66 160 2
091 3  075  1   48 28  06 01 00 00 01 07 03 01 04 00 01 00 02 02      1
 133  05 13 00 34 18 45 01 12 140   107  03 13 04 30 16 37 04 42 080 2
092 3  075  1   75 52  08 06 04 00 02 08 02 03 06 02 01 00 05 05      1
 120  03 13 00 43 08 36 04 30 101   137  01 15 02 39 18 41 04 45 108 2
093 3  086  1   60 48  09 01 00 00 02 08 03 02 09 04 02 02 04 02      1
 117  00 16 00 42 06 17 13 60 100   110  00 16 00 44 02 27 11 69 068 2
094 3  082  1   60 44  08 04 02 00 02 09 02 03 03 02 01 01 03 04      1
 145  05 13 07 43 07 40 09 63 116   142  01 15 09 49 20 47 07 57 104 2
095 3  127  1   72 73  13 06 04 01 03 11 03 03 13 04 00 00 01 06      1
 138  00 16 04 47 12 40 12 69 212   143  00 16 00 47 06 39 12 79 220 2
096 3  118  1   47 55  09 06 01 00 02 08 03 02 13 04 02 00 02 03      1
 092  03 15 00 49 10 45 03 51 100   093  00 16 09 52 08 48 00 69 080 2
097 3  130  1   75 80  15 06 04 01 04 13 03 03 13 03 02 02 04 07      1
 114  03 13 00 53 00 43 16 93 128   112  30 14 00 54 05 38 15 96 120 2
098 3  118  2   60 64  11 06 03 00 02 10 03 03 10 04 00 01 05 06      1
 125  01 16 04 49 06 45 15 75 140   128  07 11 00 51 13 46 13 87 140 2
099 3  141  1   71 76  11 06 04 01 03 11 03 03 13 04 02 02 05 08      1
 127  00 16 00 53 10 47 16 93 180   148  00 16 00 54 06 49 16108 220 2
100 3  120  1   58 65  11 06 04 01 03 09 03 03 09 04 01 01 04 06      1
 125  00 16 00 39 05 20 18 75 200   128  00 16 00 41 04 15 18 84 200 2
101 3  131  1   75 80  13 06 04 01 03 13 03 03 14 04 01 02 06 07      1
 141  00 16 00 53 05 49 16 78 204   141  00 16 00 51 06 50 14 81 204 2
102 3  132  1   75 83  13 06 04 01 04 12 03 03 13 04 02 02 07 08      1
 142  00 16 00 52 06 48 17 99 188   147  02 14 00 55 03 47 18120 180 2
103 3  112  1   73 70  11 06 04 01 04 12 03 03 10 04 02 01 05 04      1
 150  04 14 00 49 04 42 14 63 200   149  00 16 00 48 02 36 15 66 200 2
104 3  128  1   75 84  13 06 04 01 05 14 03 03 14 04 02 01 06 08      1
 177  02 14 00 50 03 44 20 84 288   166  01 15 00 53 04 50 17 84 252 2
105 3  114  1   62 65  09 06 03 00 02 11 03 03 11 04 02 02 03 06      1
 130  04 14 00 52 05 45 08 63 160   111  07 09 03 49 07 49 00 54 140 2
106 3  115  1   75 74  11 06 04 01 02 11 03 03 13 04 02 02 06 06      1
 131  00 16 00 48 03 30 17 90 148   137  00 16 01 43 06 46 18 90 148 2
107 3  078  1   59 43  07 02 02 00 01 08 03 03 07 04 00 00 03 03      1
 115  10 06 04 35 16 32 15 57 080   137  06 10 03 37 18 47 17 69 080 2
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108 3  125  1   75 80  13 06 04 01 05 14 03 03 13 04 01 02 05 06      1
 156  00 16 00 50 02 22 18 99 220   172  00 16 02 53 08 45 20120 240 2
109 3  115  1   24 32  07 01 01 00 01 07 02 01 05 02 00 00 03 02      1
 035  12 07 07 42 30 32 00 36 040   069  05 11 07 49 16 40 00 30 076 2
110 3  104  1   65 61  09 06 04 01 02 08 03 03 09 03 02 02 04 05      1
 093  00 16 01 39 02 03 14 51 116   100  01 16 01 44 06 27 13 54 100 2
111 3  076  1   64 42  08 02 04 01 01 04 03 01 08 03 01 00 03 03      1
 129  02 14 00 43 04 39 04 42 100   130  03 13 04 45 18 49 05 51 080 2
112 3  133  2   45 60  07 06 04 01 03 09 03 03 07 04 01 01 05 06      1
 120  00 16 00 50 06 37 13 69 180   118  00 16 00 51 04 39 13 66 176 2
113 3  122  1   72 73  11 06 04 01 04 10 03 03 16 02 00 02 05 06      1
 120  03 13 03 48 06 29 19 90 140   180  00 14 00 44 08 26 18 93 140 2
114 3  131  2   73 74  09 06 04 01 02 08 03 03 16 04 00 02 07 09      1
 128  00 16 02 50 04 40 16 60 200   103  03 13 00 54 03 42 17 84 104 2
115 3  157  2   56 72  10 06 04 01 03 08 03 03 12 04 02 02 06 08      1
 096  00 16 00 51 03 29 15 75 160   086  00 16 00 48 00 19 16 75 160 2
116 3  110  1   56 58  09 06 04 00 02 10 03 03 10 02 01 00 04 04      1
 114  04 16 03 40 16 41 16 63 120   112  04 14 02 37 14 42 15 60 124 2
117 3  150  1   63 76  13 06 04 00 04 10 03 03 11 04 02 02 07 07      1
 140  00 16 02 47 18 47 19 93 260   142  04 16 03 40 15 40 19 90 260 2
118 3  132  1   56 64  09 06 04 01 03 09 03 03 10 02 01 01 06 06      1
 123  04 13 03 48 00 39 10 81 180   122  04 14 01 47 01 37 09 84 176 2
119 3  142  1   67 74  12 06 04 01 04 11 03 03 11 03 01 02 05 08      1
 130  04 15 00 51 06 45 17 87 200   132  03 16 00 58 05 41 17 90 204 2
120 3  140  1   60 70  11 06 04 00 02 10 03 03 09 04 02 01 06 09      1
 155  03 14 00 51 10 30 18 90 220   146  02 16 00 46 04 15 15 87 220 2
```

Key

SUB 1-3, GROUP 5, AGE 8-10, SEX 13, BRSS 17-18, BRRS 20-21, RUN 24-25, BAL 27-28, HEEL 30-31, TAP 33-34, JCLAP 36-37, STJ 39-40, CATCH 42-43, THROW 45-46, RESPSP 48-49, LINE 51-52, CIRCLE 54-55, PENCILS 57-58, CARDS 60-61, DOTS 63-64/ CPAGE1 2-4, IMERR1 7-8, IMSCOR1 10-11, RAERR1 13-14, RASCOR1 16-17, RBERR1 19-20, RBSCOR1 22-23,JJ1 25-26, TCC1 27-29, DS1 31-33, CPAGE2 37-39, IMERR2 42-43, IMSCOR2 45-46, RAERR2 48-49, RASCOR2 51-52, RBERR2 54-55, RBSCOR2 57-58, JJ2 60-61, TCC2 62-64, DS2 66-68

Appendix G

A Key to Acronyms Used for Variables in the Data Set of Appendix F

APPENDIX G

Table 27

A Key to Acronyms Used for Variables in the Data Set of Appendix F

Demographic Variables

AGE	Age (in months)
GROUP	Group to which student had been assigned
SEX	Sex of student (1=Male, 2=Female)
SUB	Suject number

Bruininks Variables

BRSS	Standard Score on Bruininks Short Form Test
BRRS	Raw Score on Bruininks Short Form Test
RUN	Subtest 1.1 of Bruininks Short Form Test
BAL	Subtest 2.2 of Bruininks Short Form Test
HEEL	Subtest 2.7 of Bruininks Short Form Test
TAP	Subtest 3.1 of Bruininks Short Form Test
JCLAP	Subtest 3.6 of Bruininks Short Form Test
STJ	Subtest 4.1 of Bruininks Short Form Test
CATCH	Subtest 5.3 of Bruininks Short Form Test
THROW	Subtest 5.5 of Bruininks Short Form Test
RESPSP	Subtest 6.1 of Bruininks Short Form Test
LINE	Subtest 7.3 of Bruininks Short Form Test
CIRCLE	Subtest 7.5 of Bruininks Short Form Test
PENCILS	Subtest 7.8 of Bruininks Short Form Test
CARDS	Subtest 8.3 of Bruininks Short Form Test
DOTS	Subtest 8.7 of Bruininks Short Form Test

Cornish variables

CPAGE1	Cornish test, % of Developmental Age, Admin 1
IMERR1	Cornish test, Imitative Crawling, Error score, Admin 1
IMSCOR1	Cornish test, Imitative Crawling score, Admin 1
RAERR1	Cornish test, Rope Test A, Error score, Admin 1
RASCOR1	Cornish test, Rope test A score, Admin 1
RBERR1	Cornish test, Rope test B, Error score, Admin 1
RBSCOR1	Cornish test, Rope test B score, Admin 1
JJ1	Cornish test, Jumping Jacks score, Admin 1
TCC1	Cornish test, Throw-Clap-Catch score, Admin 1
DS1	Cornish test, Dominant strength score, Admin 1

all tests with 2 at the end of their acronym refer to the SECOND administrations of the Cornish test scores (as noted above)

Appendix H

Raw Data for 21 "Repeat" Subjects
(collected) May, 1982 and October/November, 1983)

APPENDIX H

07	06	1	1	48	20	33	27	34	28	103	1	121	24	32	80	87
08	07	1	1	8	20	10	24	16	24	129	1	146	24	18	16	84
32	08	1	2	65	26	32	24	38	28	112	2	130	35	52	82	92
12	14	1	1	28	20	39	24	31	24	128	1	146	24	43	82	105
44	16	1	2	109	46	49	55	52	59	93	1	110	60	61	115	121
45	17	1	2	97	40	40	36	46	44	102	1	120	45	56	119	123
19	20	1	1	52	21	26	24	29	26	99	1	117	24	30	58	67
20	21	1	1	46	20	46	26	48	28	130	1	148	24	48	85	90
21	22	1	1	9	20	26	24	17	24	138	2	156	24	29	77	80
23	23	1	1	66	27	31	33	33	35	95	1	113	50	54	83	99
51	26	1	2	119	50	62	55	53	40	125	1	143	65	73	98	67
26	27	1	1	32	20	37	24	33	24	123	1	141	24	45	73	69
30	29	1	1	33	20	36	24	37	24	131	1	149	24	37	99	94
03	31	2	1	59	24	51	41	52	43	116	1	133	24	53	82	71
33	38	2	2	93	39	39	43	48	54	91	1	108	62	62	116	125
37	42	2	2	98	41	48	32	56	45	125	1	142	65	73	117	116
38	43	2	2	121	51	57	62	61	68	111	1	128	54	69	152	157
46	50	2	2	89	37	51	46	59	57	109	1	126	66	70	123	123
49	54	2	2	109	46	59	65	66	74	99	1	116	56	61	121	138
59	58	2	2	94	39	45	43	52	52	102	2	119	41	51	76	92
60	60	2	2	117	49	50	57	55	63	90	1	107	75	71	113	116

Key

NEWSUB 1-2, OLDSUB 4-5, NEWGROUP 7, OLDGROUP 9, BLR 11-13, BLS 15-16, BSR1 18-19, BSS1 21-22, BSR2 24-25, BSS2 27-28, AGE1 31-33, SEX 36, AGE2 42-44, BSS3 47-48, BSR3 51-52, CPAGE1 54-56, CPAGE2 58-60

Appendix I

A Key to Acronyms Used for Variables in the "Repeat" Data Set of Appendix H

APPENDIX I

Table 28

A Key to Acronyms Used for Variables in the "Repeat" Data Set of Appendix H

Demographic Variables

AGE1	Age at time of May '82 Bruininks Test
AGE2	Age at time of October/November '83 Bruininks Test
NEWGROUP	Classification group in October '83
NEWSUB	Subject number as given in October/November '83 Study
OLDGROUP	Classification group in May '82
OLDSUB	Subject number as given in May '82 Study
SEX	Sex of subject (1=Male, 2=Female)

Bruininks Variables

BLR	Bruininks Long Form Raw Score (May '82)
BLS	Bruininks Long Form Standard Score (May '82)
BSR1	Bruininks Short Form Raw Score, 1 st Administration, May '82
BSR2	Bruininks Short Form Raw Score, 2 nd Administration, May '82
BSR3	Bruininks Short Form Raw Score, 3 rd Administration, October/November '83
BSS1	Bruininks Short Form Standard Score, 1 st Administration, May '82
BSS2	Bruininks Short Form Standard Score, 2 nd Administration, May '82
BSS3	Bruininks Short Form Standard Score, 3 rd Administration, October/November '83

Cornish Variables

CPAGE1	Cornish Test, % of Developmental Age, Admin. 1, (October/November '83)
CPAGE2	Cornish Test, % of Developmental Age, Admin. 2, (October/November '83)

Appendix J

Tables of Descriptive Statistics
for October/November, 1983 Data

APPENDIX J

Table 29

Descriptive Statistics, All variables, All groups, October/November 1983 Data (N=120)

VARIABLE	MEAN	STD DEV	MINIMUM	MAXIMUM
AGE	116.750	23.663	62.000	157.000
BRSS	52.333	17.447	24.000	75.000
BRRS	53.775	20.538	6.000	85.000
RUN	8.008	3.654	0.0	15.000
BAL	4.800	1.881	0.0	6.000
HEEL	2.842	1.645	0.0	4.000
TAP	.475	.501	0.0	1.000
JCLAP	2.392	1.343	0.0	5.000
STJ	8.217	3.231	0.0	14.000
CATCH	2.683	.661	0.0	3.000
THROW	2.375	.861	0.0	5.000
RESPSP	8.117	4.571	0.0	16.000
LINE	2.967	1.378	0.0	4.000
CIRCLE	1.025	.750	0.0	2.000
PENCILS	.942	.802	0.0	2.000
CARDS	4.008	1.836	0.0	8.000
DOTS	4.800	2.117	1.000	9.000
CPAGE1	99.250	38.865	0.0	177.000
IMERR1	4.817	5.269	0.0	17.000
IMSCOR1	11.667	5.010	0.0	16.000
RAERR1	2.225	2.923	0.0	12.000
RASCOR1	41.117	16.840	0.0	88.000
RBERR1	7.167	6.822	0.0	34.000
RBSCOR1	32.833	15.537	0.0	53.000
JJ1	9.375	6.724	0.0	20.000
TCC1	52.417	29.911	0.0	108.000
DS1	136.558	55.737	4.000	288.000
CPAGE2	104.783	37.796	0.0	180.000
IMERR2	5.375	7.455	0.0	60.000
IMSCOR2	12.067	4.375	0.0	16.000
RAERR2	2.033	3.106	0.0	14.000
RASCOR2	41.525	16.693	0.0	58.000
RBERR2	7.542	5.744	0.0	20.000
RBSCOR2	33.867	15.110	0.0	52.000
JJ2	9.958	6.537	0.0	20.000
TCC2	58.067	32.063	0.0	120.000
DS2	136.783	53.496	20.000	280.000

Table 30

Descriptive Statistics, All Variables, Learning Disabled - APE Students (N=30)

VARIABLE	MEAN	STD DEV	MINIMUM	MAXIMUM
AGE	110.500	28.241	65.000	156.000
BRSS	30.233	10.477	24.000	63.000
BRRS	28.567	17.302	6.000	61.000
RUN	3.300	3.019	0.0	9.000
BAL	2.933	2.033	0.0	6.000
HEEL	1.100	1.561	0.0	4.000
TAP	.067	.254	0.0	1.000
JCLAP	1.100	1.213	0.0	4.000
STJ	4.567	3.126	0.0	11.000
CATCH	2.033	.964	0.0	3.000
THROW	1.667	.844	0.0	3.000
RESPSP	3.633	4.064	0.0	12.000
LINE	1.900	1.689	0.0	4.000
CIRCLE	.633	.669	0.0	2.000
PENCILS	.367	.669	0.0	2.000
CARDS	2.133	1.137	0.0	5.000
DOTS	2.767	1.194	1.000	5.000
CPAGE1	51.767	34.973	0.0	100.000
IMERR1	10.600	5.562	0.0	17.000
IMSCOR1	5.567	4.614	0.0	14.000
RAERR1	2.333	3.477	0.0	12.000
RASCOR1	21.100	21.379	0.0	54.000
RBERR1	7.733	8.056	0.0	34.000
RBSCOR1	22.633	20.059	0.0	50.000
JJ1	2.333	3.854	0.0	13.000
TCC1	19.200	23.975	0.0	84.000
DS1	99.267	52.144	4.000	232.000
CPAGE2	58.300	37.029	0.0	113.000
IMERR2	12.067	10.560	0.0	60.000
IMSCOR2	7.167	4.728	0.0	16.000
RAERR2	2.867	4.455	0.0	14.000
RASCOR2	21.433	21.182	0.0	54.000
RBERR2	6.500	7.162	0.0	20.000
RBSCOR2	19.700	20.038	0.0	52.000
JJ2	3.500	4.939	0.0	17.000
TCC2	20.767	23.796	0.0	66.000
DS2	109.267	52.487	20.000	240.000

Table 31

Descriptive Statistics, All Variables, Learning Disabled - No APE Students (N=30)

VARIABLE	MEAN	STD DEV	MINIMUM	MAXIMUM
AGE	124.300	15.175	84.000	148.000
BRSS	54.200	11.625	30.000	75.000
BRRS	61.700	9.033	42.000	80.000
RUN	9.033	1.691	5.000	13.000
BAL	5.600	.968	3.000	6.000
HEEL	3.400	1.133	0.0	4.000
TAP	.600	.498	0.0	1.000
JCLAP	2.967	.928	1.000	5.000
STJ	9.733	1.660	6.000	13.000
CATCH	2.933	.254	2.000	3.000
THROW	2.733	.740	1.000	5.000
RESPSP	9.700	3.271	1.000	16.000
LINE	3.233	1.104	0.0	4.000
CIRCLE	.900	.759	0.0	2.000
PENCILS	1.067	.691	0.0	2.000
CARDS	4.433	1.431	2.000	8.000
DOTS	5.500	1.717	1.000	9.000
CPAGE1	110.900	18.830	76.000	152.000
IMERR1	3.433	3.319	0.0	13.000
IMSCOR1	13.367	3.222	6.000	16.000
RAERR1	2.733	2.876	0.0	10.000
RASCOR1	49.167	5.305	30.000	57.000
RBERR1	7.400	6.201	0.0	25.000
RBSCOR1	36.767	11.831	5.000	50.000
JJ1	10.867	5.686	0.0	19.000
TCC1	62.300	15.189	27.000	96.000
DS1	149.067	41.886	80.000	272.000
CPAGE2	115.600	19.262	67.000	157.000
IMERR2	3.567	3.626	0.0	12.000
IMSCOR2	13.167	3.291	4.000	16.000
RAERR2	2.267	3.028	0.0	11.000
RASCOR2	50.200	3.398	44.000	56.000
RBERR2	9.300	4.276	2.000	18.000
RBSCOR2	37.400	8.286	19.000	50.000
JJ2	11.967	4.817	0.0	20.000
TCC2	66.300	19.999	0.0	105.000
DS2	148.667	46.967	48.000	280.000

Table 32

Descriptive Statistics, All Variables, Non-Disabled Students (N=60)

VARIABLE	MEAN	STD DEV	MINIMUM	MAXIMUM
AGE	116.100	23.976	62.000	157.000
BRSS	62.450	11.806	24.000	75.000
BRRS	62.417	15.249	19.000	85.000
RUN	9.850	2.406	3.000	15.000
BAL	5.333	1.503	1.000	6.000
HEEL	3.433	1.254	0.0	4.000
TAP	.617	.490	0.0	1.000
JCLAP	2.750	1.159	0.0	5.000
STJ	9.283	2.408	2.000	14.000
CATCH	2.883	.324	2.000	3.000
THROW	2.550	.723	1.000	3.000
RESPSP	9.567	3.890	0.0	16.000
LINE	3.367	1.025	0.0	4.000
CIRCLE	1.283	.691	0.0	2.000
PENCILS	1.167	.785	0.0	2.000
CARDS	4.733	1.656	1.000	8.000
DOTS	5.467	2.021	2.000	9.000
CPAGE1	117.167	27.004	35.000	177.000
IMERR1	2.617	3.532	0.0	16.000
IMSCOR1	13.867	3.122	0.0	16.000
RAERR1	1.917	2.644	0.0	12.000
RASCOR1	47.100	7.772	27.000	88.000
RBERR1	6.767	6.536	0.0	30.000
RBSCOR1	35.967	12.228	0.0	53.000
JJ1	12.150	5.816	0.0	20.000
TCC1	64.083	25.679	0.0	108.000
DS1	148.950	55.895	32.000	288.000
CPAGE2	122.617	23.313	69.000	180.000
IMERR2	2.933	4.509	0.0	30.000
IMSCOR2	13.967	2.407	5.000	16.000
RAERR2	1.500	2.127	0.0	9.000
RASCOR2	47.233	7.692	20.000	58.000
RBERR2	7.183	5.485	0.0	20.000
RBSCOR2	39.183	9.603	6.000	50.000
JJ2	12.183	5.873	0.0	20.000
TCC2	72.600	25.335	0.0	120.000
DS2	144.600	53.055	40.000	260.000